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Fecha: 31 de marzo de 2015
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ADOPCIÓN DE NORMA FEDERAL

ELECTRIC POWER GENERATION, TRANSMISSION, AND DISTRIBUTION; ELECTRICAL PROTECTIVE EQUIPMENT, FINAL RULE

("Generación, Transmisión y Distribución de Energía Eléctrica; Equipo de Protección, Regla Final")

Parts 4 OSH 1910 y 10 OSH 1926
79 FR No. 70 (20316-20743) – April 11, 2014
Expediente del Departamento de Estado Núm. ***2343***

AUTHENTICATED U.S. GOVERNMENT INFORMATION GPO



FEDERAL REGISTER

Vol. 79 Friday,
No. 70 April 11, 2014

Part II

Department of Labor

Occupational Safety and Health Administration

29 CFR Parts 1910 and 1926

Electric Power Generation, Transmission, and Distribution; Electrical Protective Equipment; Final Rule

DEPARTMENT OF LABOR

Occupational Safety and Health Administration

29 CFR Parts 1910 and 1926

[Docket No. OSHA–S215–2006–0063]

RIN 1218–AB67

Electric Power Generation, Transmission, and Distribution; Electrical Protective Equipment

AGENCY: Occupational Safety and Health Administration (OSHA), Labor.

ACTION: Final rule.

SUMMARY: OSHA last issued rules for the construction of transmission and distribution installations in 1972. Those provisions are now out of date and inconsistent with the more recently promulgated general industry standard covering the operation and maintenance of electric power generation, transmission, and distribution lines and equipment. OSHA is revising the construction standard to make it more consistent with the general industry standard and is making some revisions to both the construction and general industry requirements. The final rules for general industry and construction include new or revised provisions on host employers and contractors, training, job briefings, fall protection, insulation and working position of employees working on or near live parts, minimum approach distances, protection from electric arcs, deenergizing transmission and distribution lines and equipment, protective grounding, operating mechanical equipment near overhead power lines, and working in manholes and vaults. The revised standards will ensure that employers, when appropriate, must meet consistent requirements for work performed under the construction and general industry standards.

The final rule also revises the general industry and construction standards for electrical protective equipment. The existing construction standard for the design of electrical protective equipment, which applies only to electric power transmission and distribution work, adopts several national consensus standards by reference. The new standard for electrical protective equipment, which matches the corresponding general industry standard, applies to all construction work and replaces the incorporation of out-of-date consensus standards with a set of performance-oriented requirements that is consistent with the latest revisions of the relevant consensus standards. The final construction rule also includes new requirements for the safe use and care of electrical protective equipment to complement the equipment design provisions. Both the general industry and construction standards for electrical protective equipment will include new requirements for equipment made of materials other than rubber.

OSHA is also revising the general industry standard for foot protection. This standard applies to employers performing work on electric power generation, transmission, and distribution installations, as well as employers in other industries. The final rule removes the requirement for employees to wear protective footwear as protection against electric shock.

DATES: The final rule becomes effective on July 10, 2014. (Certain provisions have compliance deadlines after this date as explained later in this preamble.)

ADDRESSES: In accordance with 28 U.S.C. 2112(a), the Agency designates the Associate Solicitor of Labor for Occupational Safety and Health, Office of the Solicitor of Labor, Room S4004, U.S. Department of Labor, 200 Constitution Avenue NW., Washington, DC 20210, to receive petitions for review of the final rule.

FOR FURTHER INFORMATION CONTACT:

General information and press inquiries: Mr. Frank Meilinger, Office of Communications, Room N3647, OSHA, U.S. Department of Labor, 200 Constitution Avenue NW., Washington, DC 20210; telephone (202) 693–1999.

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SUPPLEMENTARY INFORMATION:

Table of Contents

I. Executive Summary
A. Introduction
B. Need for Regulation
C. Affected Establishments
D. Benefits, Net Benefits, and Cost Effectiveness
E. Cost Effectiveness
F. Compliance Costs
G. Economic Impacts
H. Final Regulatory Flexibility Analysis
II. Background
A. Acronyms and Abbreviations
B. Need for the Rule
C. Accident Data
D. Significant Risk and Reduction in Risk
III. Development of the Final Rule
A. History of the OSHA Standards
B. Relevant Consensus Standards
C. Advisory Committee on Construction Safety and Health
IV. Legal Authority
V. Summary and Explanation of the Final Rule
A. Section 1926.97, Electrical Protective Equipment
B. Subpart V, Electric Power Transmission and Distribution
C. Part 1910, Revisions
D. Part 1926, Removal of Incorporations by Reference
E. Part 1926, Subpart CC Revisions
VI. Final Economic Analysis and Regulatory Flexibility Analysis
A. Introduction
B. Need for the Rule
C. Examination of Alternative Regulatory Approaches
D. Profile of Affected Industries
E. Benefits, Net Benefits, and Cost Effectiveness
F. Technological Feasibility
G. Costs of Compliance
H. Final Regulatory Flexibility Analysis
I. References
VII. Federalism
VIII. Unfunded Mandates
IX. Consultation and Coordination With Indian Tribal Governments
X. Office of Management and Budget Review Under the Paperwork Reduction Act of 1995
A. Information Collection Request for the Proposed Rule
B. Information Collection Requirements in the Final Rule
XI. State-Plan Requirements
XII. Dates
A. The New Requirements for Transferring Information Between Host Employers and Contract Employers (§§ 1926.950(c) and 1910.269(a)(3))
B. Revised Provisions on the Use of Fall Protection Systems (§§ 1926.954(b)(3)(iii) and (b)(3)(iv) and 1910.269(g)(2)(iv)(C), and (g)(2)(iv)(D))
C. Revised Requirements for Minimum Approach Distances (§§ 1926.960(c)(1) and 1910.269(l)(3))
D. New Requirements for Protecting Employees From the Hazards Associated with Electric Arcs (§§ 1926.960(g) and 1910.269(l)(8))
XIII. Authority and Signature

Executive Summary

A. Introduction

OSHA last issued rules for the construction of transmission and

distribution installations in 1972. Those provisions are now out of date and inconsistent with the more recently promulgated general industry standard covering the operation and maintenance of electric power generation, transmission, and distribution lines and equipment. OSHA is revising the construction standard to make it more consistent with the general industry standard and is making some revisions to both the construction and general industry requirements. The final rules for general industry and construction include new or revised provisions on host employers and contractors, training, job briefings, fall protection, insulation and working position of employees working on or near live parts, minimum approach distances, protection from electric arcs, deenergizing transmission and distribution lines and equipment, protective grounding, operating mechanical equipment near overhead power lines, and working in manholes and vaults. The revised standards will ensure that employers, when appropriate, must meet consistent requirements for work performed under the construction and general industry standards.

The new provisions on host employers and contractors include requirements for host employers and contract employers to exchange information on hazards and on the conditions, characteristics, design, and operation of the host employer's installation. These new provisions also include a requirement for host employers and contract employers to coordinate their work rules and procedures to protect all employees. The revised provisions on training add requirements for the degree of training to be determined by the risk to the employee for the hazard involved and for training line-clearance tree trimmers and remove the existing requirement for the employer to certify training. The revised requirements for job briefings include a new requirement for the employer to provide information about existing characteristics and conditions to the employee in charge. The revised fall protection provisions include new requirements for the use of fall restraint systems or personal fall arrest systems in aerial lifts and for the use of fall protection equipment by qualified employees climbing or changing location on poles, towers, or similar structures. The revised provisions on insulation and working position of employees working on or near live parts include new requirements relating to where an employee who is not using electrical protective equipment may work. The revised provisions on minimum approach distances include a new requirement for the employer to determine maximum anticipated per-unit transient overvoltages through an engineering analysis or, as an alternative, assume certain maximum anticipated per-unit transient overvoltages. These provisions also replace requirements for specified minimum approach distances with requirements for the employer to establish minimum approach distances using specified formulas. The new provisions for protection from electric arcs include new requirements for the employer to: Assess the workplace to identify employees exposed to hazards from flames or from electric arcs, make reasonable estimates of the incident heat energy to which the employee would be exposed, ensure that the outer layer of clothing worn by employees is flame resistant under certain conditions, and generally ensure that employees exposed to hazards from electric arcs wear protective clothing and other protective equipment with an arc rating greater than or equal to the estimated heat energy. The revised provisions on deenergizing transmission and distribution lines and equipment clarify the application of those provisions to multiple crews and to deenergizing network protectors. The revised requirements for protective grounding now permit employers to install and remove protective grounds on lines and equipment operating at 600 volts or less without using a live-line tool under certain conditions. The revised provisions for operating mechanical equipment near overhead power lines clarify that the exemption from the requirement to maintain minimum approach distances applies only to the insulated portions of aerial lifts. The revised provisions on working in manholes and vaults clarify that all of the provisions for working in manholes also apply to working in vaults and include a new requirement for protecting employees from electrical faults when work could cause a fault in a cable.

The final rule also revises the general industry and construction standards for electrical protective equipment. The existing construction standard for the design of electrical protective equipment, which applies only to electric power transmission and distribution work, adopts several national consensus standards by reference. The new standard for electrical protective equipment applies to all construction work and replaces the incorporation of out-of-date consensus standards with a set of performance-oriented requirements that is consistent with the latest revisions of the relevant consensus standards. The final construction rule also includes new requirements for the safe use and care of electrical protective equipment to complement the equipment design provisions. Both the general industry and construction standards for electrical protective equipment will include new requirements for equipment made of materials other than rubber.

OSHA is also revising the general industry standard for foot protection. This standard applies to employers performing work on electric power generation, transmission, and distribution installations, as well as employers in other industries. The final rule removes the requirement for employees to wear protective footwear as protection against electric shock.

B. Need for Regulation

Employees doing work covered by the final rule are exposed to a variety of significant hazards that can and do cause serious injury and death. As explained fully in Section II.B, Need for the Rule, later in this preamble, after carefully weighing the various potential advantages and disadvantages of using a regulatory approach to reduce risk, OSHA concludes that in this case mandatory standards represent the best choice for reducing the risks to employees. In addition, rulemaking is necessary in this case to replace older existing standards with updated, clear, and consistent safety standards. Inconsistencies between the construction and general industry standards can create difficulties for employers attempting to develop appropriate work practices for their employees. For example, an employer replacing a switch on a transmission and distribution system is performing construction work if it is upgrading the cutout, but general industry work if it is simply replacing the cutout with the same model. Under the existing standards, different requirements apply depending upon whether the work is construction or general industry work. Under the final rule, the requirements are the same.

C. Affected Establishments

The final rule affects establishments in a variety of different industries involving electric power generation, transmission, and distribution. The rule primarily affects firms that construct, operate, maintain, or repair electric power generation, transmission, or distribution installations. These firms

include electric utilities, as well as contractors hired by utilities and primarily classified in the construction industry. In addition, potentially affected firms are found in a variety of manufacturing and other industries that own or operate their own electric power generation, transmission, or distribution installations as a secondary part of their business operations. The rule also affects establishments performing line-clearance tree-trimming operations.

D. Benefits, Net Benefits, and Cost Effectiveness

OSHA expects the final rule to result in an increased degree of safety for the affected employees, thereby reducing the numbers of accidents, fatalities, and injuries associated with the relevant tasks and reducing the severity of certain injuries, such as burns or injuries that employees could sustain as a result of an arrested fall, that may still occur during the performance of some of the affected work procedures.

An estimated 74 fatalities and 444 serious injuries occur annually among employees involved in the electric power generation, transmission, and distribution work addressed by the provisions of this rulemaking. Based on a review and analysis of the incident reports associated with the reported injuries and fatalities, OSHA expects full compliance with the final rule to prevent 79.6 percent of the relevant injuries and fatalities, compared with 52.9 percent prevented with full compliance with the existing standards. Thus, OSHA estimates that the final rule will prevent approximately 19.75 additional fatalities and 118.5 additional serious injuries annually. Applying an average monetary value of $62,000 per prevented injury and a value of $8.7 million per prevented fatality results in estimated monetized benefits of $179.2 million annually.

OSHA estimated the net monetized benefits of the final rule to be about $129.7 million annually when costs are annualized at 7 percent ($179.2 million in benefits minus $49.5 million in costs), and $132.0 million when costs are annualized at 3 percent ($179.2 million in benefits minus $47.1 million in costs). Note that these net benefits exclude any unquantified benefits associated with revising existing standards to provide updated, clear, and consistent regulatory requirements for electric power generation, transmission, and distribution work. OSHA believes that the updated standards are easier to understand and to apply. Accordingly, the Agency expects the final rule to improve safety by facilitating compliance.

Table 1 summarizes the costs, benefits, net benefits, and cost effectiveness of the final rule.

TABLE 1—NET BENEFITS AND COST EFFECTIVENESS *

	7 percent	3 percent
Annualized Costs:		
Calculating Incident Energy and Arc-Hazard Assessment (Arc-Hazard Assessment).	$2.2 million	$1.8 million.
Provision of Arc-Flash Protective Equipment	$17.3 million	$15.7 million.
Fall Protection	$0.6 million	$0.4 million.
Host-Contractor Communications	$17.8 million	$17.8 million.
Expanded Job Briefings	$6.7 million	$6.7 million.
Additional Training	$3.0 million	$2.7 million.
Other costs for employees not already covered by § 1910.269	$0.2 million	$0.2 million.
MAD Costs	$1.8 million	$1.8 million.
Total Annual Costs	$49.5 million	$47.1 million.
Annual Benefits:		
Number of Injuries Prevented	118.5	118.5.
Number of Fatalities Prevented	19.75	19.75.
Monetized Benefits (Assuming $62,000 per injury and $8.7 million per fatality prevented.	$179.2 million	$179.2 million.
OSHA standards that are updated and consistent	Unquantified	Unquantified.
Total Annual Benefits	115 injuries and 19.75 fatalities prevented.	118.5 injuries and 19.75 fatalities prevented.
Net Benefits (Benefits minus Costs):	$129.7 million	$132.0 million.

*Totals may not equal the sum of the components due to rounding.
Source: Office of Regulatory Analysis, OSHA. Details provided in text.

E. Cost Effectiveness

OSHA estimates that compliance with the final rule will result in the prevention of an one fatality and six injuries per $2.4 million in costs (using a 7-percent annualization rate) and one fatality and six injuries per $2.2 million in costs (using a 3-percent annualization rate).

F. Compliance Costs

The estimated costs of compliance with this rule represent the additional costs necessary for employers to achieve full compliance. They do not include costs for employers that are already in compliance with the requirements imposed by the final; nor do they include costs employers must incur to achieve full compliance with existing applicable requirements.

OSHA based the preliminary Regulatory Impact Analysis and Initial Regulatory Flexibility Analysis (PRIA) for the proposed rule, in part, on a report prepared by SAD Corp. (Exhibit 0080) under contract to OSHA. Eastern Research Group, Inc., (ERG) under contract to OSHA, assisted in preparing the analysis for the final rule presented here. With ERG's assistance, OSHA updated establishments, employment, wages, revenues, and updated the analyses in the final rule with these new cost inputs. OSHA also calculated costs for provisions of the final rule not accounted for in the PRIA. These costs are for the use of upgraded fall protection equipment resulting from revised fall protection requirements, the provision of arc-rated head and face protection for some employees, the training of employees in the use of new fall protection equipment, the calculation of minimum approach distances, and, in some cases, the use of portable protective gaps (PPGs) to comply with the new minimum approach-distance requirements. The FEA also modifies the PRIA's approach

to estimating costs for arc-hazard assessments.

OSHA estimated the total annualized cost of compliance with the present rulemaking to be between about $47.1 million (when costs are annualized at 3 percent) and $49.5 million (when costs are annualized at 7 percent). The final rule's requirements for employers to provide arc-flash protective equipment account for the largest component of the total compliance costs, at approximately $15.7 million to $17.2 million (when costs are annualized at 3 and 7 percent, respectively). Other nonnegligible compliance costs associated with the final rule include costs related to host-contractor communications ($17.8 million), job briefings ($6.7 million), training ($2.7 million to $3.0 million), minimum approach distances ($1.8 million to $1.8 million), fall protection ($0.4 million to $0.6 million), compliance with existing § 1910.269 for employees not already covered by that standard ($0.2 million), and arc-hazard assessments ($1.8 million to $2.2 million).

G. Economic Impacts

To assess the economic impacts associated with compliance with the final rule, OSHA developed quantitative estimates of the potential economic impact of the requirements in this rule on entities in each affected industry. OSHA compared the estimated costs of compliance with industry revenues and profits to provide an assessment of potential economic impacts.

The costs of compliance for the final rule are not large in relation to the corresponding annual financial flows associated with the regulated activities. The estimated costs of compliance (when annualized at 7 percent) represent about 0.007 percent of revenues and 0.06 percent of profits, on average, across all entities; compliance costs do not represent more than 0.1 percent of revenues or more than about 2 percent of profits in any affected industry.

The economic impact of the present rulemaking is most likely to consist of a small increase in prices for electricity, of about 0.007 percent on average. It is unlikely that a price increase on the magnitude of 0.007 percent will significantly alter the services demanded by the public or any other affected customers or intermediaries. If employers can substantially recoup the compliance costs of the present rulemaking with such a minimal increase in prices, there may be little effect on profits.

In general, for most establishments, it is likely that employers can pass some or all of the compliance costs along in the form of increased prices. In the event that unusual circumstances may inhibit even a price increase of 0.1 percent (the highest estimated cost as a percent of revenue in any of the affected industries), profits in any of the affected industries would be reduced by a maximum of about 2 percent.

OSHA concludes that compliance with the requirements of the final rule is economically feasible in every affected industry sector.

In addition, based on an analysis of the costs and economic impacts associated with this rulemaking, OSHA concludes that the effects of the final rule on international trade, employment, wages, and economic growth for the United States are negligible.

H. Final Regulatory Flexibility Analysis

The Regulatory Flexibility Act, as amended in 1996 by the Small Business Regulatory Enforcement Fairness Act, requires the preparation of a Final Regulatory Flexibility Analysis for certain rules promulgated by agencies (5 U.S.C. 601–612). Under the provisions of the law, each such analysis must contain: (1) A succinct statement of the need for, and objectives of, the rule; (2) A summary of the significant issues raised by the public comments in response to the initial regulatory flexibility analysis, a summary of the assessment of the agency of such issues, and a statement of any changes made in the final rule as a result of such comments; (3) a description and an estimate of the number of small entities to which the rule will apply or an explanation of why no such estimate is available; (4) a description of the projected reporting, recordkeeping, and other compliance requirements of the rule, including an estimate of the classes of small entities that will be subject to the requirement, and the type of professional skills necessary for preparation of the report or record; and (5) a description of the steps the agency took to minimize the significant economic impact on small entities consistent with the stated objectives of applicable statutes, including a statement of the factual, policy, and legal reasons for selecting the alternative adopted in the final rule, and why the agency rejected each one of the other significant alternatives to the rule considered by the agency which affect the impact on small entities.

OSHA analyzed the potential impact of the final rule on small and very small entities, as described further under the heading "Final Regulatory Flexibility Analysis," in Section VI, Final Economic Analysis and Regulatory Flexibility Analysis, later in this preamble. OSHA concludes that the compliance costs are equivalent to approximately 0.086 percent of profits for affected small entities generally, and less than approximately 2.9 percent of profits for small entities in any particular industry, and approximately 0.39 percent of profits for affected very small entities generally, and less than approximately 5.61 percent of profits for very small entities in any particular industry.

II. Background

A. Acronyms and Abbreviations

The following acronyms have been used throughout this document:

ACCSH Advisory Committee on Construction Safety and Health
AED automated external defibrillator
AGC Associated General Contractors of America
ALJ administrative law judge
ANSI American National Standards Institute
APPA American Public Power Association
ASTM American Society for Testing and Materials
BLS Bureau of Labor Statistics
BPA Bonneville Power Administration
CFOI Census of Fatal Occupational Injuries
CPL 02–01–038 the compliance directive for existing § 1910.269, CPL 02–01–038, "Enforcement of the Electric Power Generation, Transmission, and Distribution Standard" (June 18, 2003, originally CPL 2–1.38D)
CPR cardiopulmonary resuscitation
CRIEPI Central Research Institute of Electric Power Industry
EEI Edison Electric Institute
EIA Energy Information Administration
E.O. Executive Order
EPRI Electric Power Research Institute
ERG Eastern Research Group, Inc.
ESCI Electrical Safety Consultants International
Ex. Exhibit [1]
FCC Federal Communications Commission
FEA Final Economic Analysis and Regulatory Flexibility Analysis
FR flame-resistant [2]

[1] Exhibits are posted on *http://www.regulations.gov* and are accessible at OSHA's Docket Office, Docket No. OSHA–S215–2006–0063, U.S. Department of Labor, 200 Constitution Avenue NW., Room N2625, Washington, DC 20210; telephone (202) 693–2350. (OSHA's TTY number is (877) 889–5627.) OSHA Docket Office hours of operation are 8:15 a.m. to 4:45 p.m., E.T.

Throughout this notice exhibit numbers are referred to in the form Ex. XXXX, where XXXX is the last four digits of the full document number on *http://www.regulations.gov*. For example, document number OSHA–S215–2006–0063–0001 is referred to as Ex. 0001. Exhibit numbers referred to as "269–Ex." are from the record for the 1994 final rule on §§ 1910.137 and 1910.269 and are contained in Docket Number OSHA–S015–2006–0645.

[2] In citations, such as 70 FR 34822, "FR" means "**Federal Register**."

FRA flame-resistant apparel
FRECC Farmers Rural Electric Cooperative Corporation
FRFA Final Regulatory Flexibility Analysis
FTE full-time equivalent [employee]
IBEW International Brotherhood of Electrical Workers
IEC International Electrotechnical Commission
IEEE Institute of Electrical and Electronic Engineers
IMIS OSHA's Integrated Management Information System
IRFA Initial Regulatory Flexibility Analysis
IRS Internal Revenue Service
ISEA International Safety Equipment Association
MAD minimum approach distance
MAID minimum air-insulation distance
MCC motor control center
MTID minimum tool-insulation distance
NA not applicable
NAHB National Association of Home Builders
NAICS North American Industry Classification System
NAM National Association of Manufacturers
NECA National Electrical Contractors Association
NEPA National Environmental Policy Act of 1969
NESC National Electrical Safety Code
NFPA National Fire Protection Association
NIOSH National Institute for Occupational Safety and Health
NRECA National Rural Electric Cooperative Association
OIRA Office of Information and Regulatory Affairs
OMB Office of Management and Budget
OSH Act (or the Act) Occupational Safety and Health Act of 1970
OSHA Occupational Safety and Health Administration
OSHRC Occupational Safety and Health Review Commission
PPE personal protective equipment
PPG portable protective gap
PRIA Preliminary Regulatory Impact Analysis and Initial Regulatory Flexibility Analysis
PSM process safety management
p.u. per unit
RIN regulatory information number
SBA Small Business Administration
SBAR Panel (or Panel) Small Business Advocacy Review Panel
SBREFA Small Business Regulatory Enforcement Fairness Act
SER small entity representative
SIC Standard Industrial Classification
T maximum transient overvoltage, which is defined as the ratio of the 2-percent statistical switching overvoltage expected at the worksite to the nominal peak line-to-ground voltage of the system
TCIA Tree Care Industry Association
the 1994 § 1910.269 rulemaking the rulemaking in which existing §§ 1910.137 and § 1910.269 were developed and published on January 31, 1994
Tr. Transcript page number or numbers from the March 6–14, 2006, public hearing on the proposed rule [3]
Tr2. Transcript page number or numbers from the October 28, 2009, public hearing on the limited reopening of the proposed rule [4]
TVA Tennessee Valley Authority
ULCC Utility Line Clearance Coalition
USDA United States Department of Agriculture
UWUA Utility Workers Union of America
WCRI Worker Compensation Research Institute

Record citations. References in parentheses are to exhibits or transcripts in the rulemaking record. Documents from the Subpart V rulemaking record are accessible at the Docket Office under Docket OSHA–S215–2006–0063 (originally Docket S–215). (The 2006 transcripts, abbreviated as "Tr.," are listed in this docket as "exhibits" 0509 through 0515. The 2009 transcript, abbreviated as "Tr2.," is listed as "exhibit" 0571.) Because the subpart V proposal was based in large part on existing § 1910.269, OSHA has also relied on the record developed during the earlier rulemaking for that general industry standard (the 1994 § 1910.269 rulemaking). EEI "incorporate[d] into [the subpart V] record the entire record in . . . the record underlying existing Section 1910.269" (Ex. 0227). References in this preamble that are prefixed by "269" are to exhibits and transcripts in the rulemaking record from OSHA's 1994 rulemaking on § 1910.137 and § 1910.269 (59 FR 4320–4476, Jan. 31, 1994). These documents are accessible at the Docket Office under Docket OSHA–S015–2006–0645 (originally Docket S–015).[5]

Some exhibits (see, for example, Exs. 0002, 0003, 0004, and 0400) contain records of accidents that are relevant to work covered by the final rule. In several instances in this preamble, OSHA has included hyperlinks to accident descriptions from those exhibits. Those hyperlinks link to one or more accident records in OSHA's IMIS system. The hyperlinked pages contain the most recent version of those records, which might have been edited since being placed in the record for this rulemaking. Consequently, the accident descriptions could differ slightly from the description included in the rulemaking record. However, the accident record numbers in the hyperlinked page match the accident record numbers in the relevant exhibit.

B. Need for the Rule

Employees performing work involving electric power generation, transmission, and distribution are exposed to a variety of hazards, including fall, electric shock, and burn hazards, that can and do cause serious injury and death. These workers are often exposed to energized parts of the power system, and the voltages involved are generally much higher than voltages encountered in other types of work. OSHA estimates that, on average, 74 fatalities and 444 serious injuries occur annually among these workers. (See Section VI, Final Economic Analysis and Regulatory Flexibility Analysis, later in the preamble, for a detailed discussion of the methodology used to develop these estimates.)

Although some of these incidents may have been prevented with better compliance with existing safety standards, OSHA concludes that many, in fact almost half of, fatal and nonfatal injuries among employees covered by the final rule would continue to occur even if employers were in full compliance with existing standards. Discounting incidents that would potentially have been prevented with compliance with existing standards, an estimated additional 19.75 fatalities and 118.5 serious injuries will be prevented each year through full compliance with the final rule. (See Section VI, Final Economic Analysis and Regulatory Flexibility Analysis, later in the preamble, for a detailed discussion of the methodology used to develop these estimates.)

This rulemaking will have the additional benefit of providing updated, clear, and consistent safety standards for electric power generation, transmission, and distribution work. OSHA currently has different standards covering construction and general industry work on electric power transmission and distribution systems. In most instances, the work practices used by employees are the same whether they are performing construction or general industry work. Which standard applies to a particular job depends upon whether the employer is altering the system (construction work) or maintaining the system (general industry work). For example, an employer replacing a cutout (disconnect switch) on a transmission and distribution system is performing construction work if it is upgrading the cutout, but general industry work if it is simply replacing the cutout with the same model. Since the work practices used by the employees would most

[3] Exhibit numbers 0509 through 0515.

[4] Exhibit number 0571.

[5] Documents in the records, with the exception of copyrighted material such as ASTM standards, are also generally available electronically at *www.regulations.gov*. The subpart V and 1994 § 1910.269 dockets are available at: *http://www.regulations.gov/#!docketDetail;dct=FR+PR+N+O+SR+PS;rpp=250;po=0;D=OSHA-S215-2006-0063* and *http://www.regulations.gov/#!docketDetail;dct=FR+PR+N+O+SR+PS;rpp=250;po=0;D=OSHA-S015-2006-0645*, respectively.

likely be identical, the applicable OSHA standards should be as similar as possible. Inconsistencies between the construction and general industry standards can create difficulties for employers attempting to develop appropriate work practices for their employees. Currently, it is conceivable that, for work involving two or more cutouts, different and conflicting OSHA standards (that is, one for construction work, the other for general industry work) might apply. For this reason, employers and employees have told OSHA that it should make the two standards more consistent with each other. This final rule does so. (This issue is addressed in greater detail in the summary and explanation for § 1926.950, in Section V, Summary and Explanation of the Final Rule, later in this preamble.)

Moreover, the final rule adds important updates to, and clarifies, existing standards. The existing standards for the construction of electric power transmission and distribution lines and equipment and for electrical protective equipment are contained in subpart V of OSHA's construction standards (29 CFR 1926.950 through 1926.960). Subpart V was promulgated on November 23, 1972, around 40 years ago (37 FR 24880, Nov. 23, 1972). Some of the technology involved in electric power transmission and distribution work has changed since then, and the current standards do not reflect those changes. For example, methods for determining minimum approach distances have become more exact since 1972, and the minimum approach distances in existing § 1926.950(c)(1) are not based on the latest methodology. The minimum approach distances in the final rule are more protective and more technologically sound than the distances specified in the existing standard. Even the newer general industry standards on the operation and maintenance of electric power generation, transmission, and distribution installations (29 CFR 1910.269) and electrical protective equipment (29 CFR 1910.137) are not entirely consistent with the latest advances in technology.

Finally, the final rule clarifies certain confusing parts of the regulations. See, for example, *Wisconsin Elec. Power Co.* v. *OSHRC,* 567 F.2d 735, 738 (7th Cir. 1977) ("[r]evision of the regulations by any competent draftsman would greatly improve their clarity").

C. Accident Data

OSHA has looked to several sources for information on accidents in the electric utility industry in preparing this final rule. Besides OSHA's own accident investigation files (recorded in the Agency's Integrated Management Information System (IMIS)), statistics on injuries are compiled by the Edison Electric Institute (EEI) and by the International Brotherhood of Electrical Workers (IBEW). Additionally, the Bureau of Labor Statistics (BLS) publishes accident data, including incidence rates for total cases, lost-workday cases, and lost workdays, and the National Institute for Occupational Safety and Health (NIOSH) publishes accident data as part of its Fatality Assessment and Control Evaluation Program.

To develop estimates of the potential benefits associated with the standards during the proposal stage, CONSAD Corp., under contract to OSHA, researched and reviewed potential sources of useful data. CONSAD, in consultation with the Agency, determined that the most reliable data sources for this purpose were OSHA's IMIS data and the Census of Fatal Occupational Injuries developed by BLS. A majority of the accidents reviewed by CONSAD involved electrocutions or shocks. In addition, a significant percentage of victims (5.5 percent) suffered from burns to their arms, abdomen, or legs from electric arc blasts and flashes, and another sizeable group of victims (3.2 percent) died or sustained injuries after falling out of vehicle-mounted aerial lifts.[6]

D. Significant Risk and Reduction in Risk

Section 3(8) of the Occupational Safety and Health Act of 1970 (OSH Act or the Act) defines an "occupational safety and health standard" as "a standard which requires conditions, or the adoption or use of one or more practices, means, methods, operations, or processes, reasonably necessary or appropriate to provide safe or healthful employment and places of employment." 29 U.S.C. 652(8). This definition has been interpreted to require OSHA to make a threshold showing of "significant risk" before it can promulgate a safety or health standard. See, for example, *Industrial Union Dept., AFL–CIO* v. *American Petroleum Institute* (*Benzene*), 448 U.S. 607 (1980) (plurality opinion); see also, for example, *UAW* v. *OSHA* (*Lockout/Tagout II*), 37 F.3d 665 (D.C. Cir. 1994).

[6] " Analytical Support and Data Gathering for a Preliminary Economic Analysis for Proposed Standards for Work on Electric Power Generation, Transmission, and Distribution Lines and Equipment (29 CFR 1910.269 and 29 CFR 1926—Subpart V)," 2005, CONSAD Research Corp. (Ex. 0080).

The Agency's obligation to show significant risk is not, however, a "mathematical straitjacket." *Benzene,* 448 U.S. at 655. In fact, the Agency has discretion to "determine, in the first instance, what it considers to be a 'significant' risk[,]" and it "is not required to support its finding that a significant risk exists with anything approaching scientific certainty." *Id.* at 655–56; see also, for example, *Public Citizen Health Research Group* v. *Tyson* (*Ethylene Oxide*), 796 F.2d 1479, 1486 (D.C. Cir. 1986).

Although OSHA makes significant risk findings for both health and safety standards, see *Lockout/Tagout II,* 37 F.3d 665, the methodology used to evaluate risk in safety rulemakings is more straightforward. Unlike the risks related to health hazards, which "may not be evident until a worker has been exposed for long periods of time to particular substances," the risks associated with safety hazards such as burns and falls, "are generally immediate and obvious." *Benzene,* 448 U.S. at 649, n.54. See also 59 FR 28594, 28599 (June 2, 1994) (proposed rule for longshoring and marine terminals, explaining that health hazards "are frequently undetectable because they are subtle or develop slowly or after long latency periods," whereas safety hazards "cause immediately noticeable physical harm"). As OSHA explained in its lockout-tagout rulemaking:

> For health standards, such as benzene, risk estimates are commonly based upon mathematical models (e.g., dose response curves) and the benefits are quantified by estimating the number of future fatalities that would be prevented under various exposure reductions. [In contrast, f]or safety standards risk is based upon the assumption that past accident patterns are representative of future ones. OSHA estimates benefits [for safety standards] by determining the percentage of accidents that will be prevented by compliance with the standard. . . . [58 FR 16612, 16623, Mar. 30, 1993]

OSHA's Final Economic and Regulatory Flexibility Analysis presents the Agency's assessment of the risks and benefits of this final rule. (See Section VI, Final Economic Analysis and Regulatory Flexibility Analysis, later in the preamble.) In these analyses, as previously mentioned, OSHA estimates that there are 74 fatalities and 444 serious injuries among employees covered by this final rule each year. The Agency has determined that almost half of those injuries and fatalities would have occurred even if employers were in full compliance with existing standards. (See Section VI, Final Economic Analysis and Regulatory Flexibility Analysis, later in the preamble, in

which OSHA estimates that 53 percent of injuries and fatalities could have been prevented through full compliance with existing standards.) The accident data reviewed during this rulemaking, as explained in detail in the economic and regulatory analyses, reveals that the injuries and fatalities suffered by workers in power generation, transmission, and distribution result from electric shocks, burns from electric arcs, and falls, as well as other types of harmful incidents, including ones in which employees are struck by, struck against, or caught between, objects. Based on the large number of injuries and fatalities occurring in this industry each year, and the fact that existing standards are inadequate to prevent almost half of those incidents, OSHA has determined that employees working on electric power generation, transmission, and distribution installations are currently exposed to a significant risk of injury or death.[7]

The Agency estimates that the changes implemented in this final rule will prevent 19.75 fatalities and 118.5 serious injuries each year. (See Section VI, Final Economic Analysis and Regulatory Flexibility Analysis, later in the preamble.) OSHA, therefore, concludes that this final standard substantially reduces the significant risk that currently exists at power generation, transmission, and distribution worksites. As noted in Section VI, Final Economic Analysis and Regulatory Flexibility Analysis, later in the preamble, the various new provisions and amendments being adopted target the hazards the Agency has identified as contributors to the significant risk associated with electric power generation, transmission, and distribution work. Therefore, each element of this final rule is reasonably necessary and appropriate to achieve the anticipated reduction in overall risk.

No rulemaking participants meaningfully disputed OSHA's conclusion that the aforementioned estimates establish a significant risk for power generation, transmission, and distribution work. EEI, however, argued that OSHA has an obligation to make an independent significant risk showing for each of the hazards addressed by this rulemaking (See, for example, Exs. 0227, 0501; see also Ex. 0237 (comments of the American Forest & Paper Association).) OSHA does not agree that it is required to make multiple, hazard-specific significant risk findings.

As OSHA has explained in prior rulemakings, "[v]ertical standards [such as § 1910.269 and subpart V of part 1926] apply specifically to a given industry" or type of work (59 FR 28596 (proposed rule for longshoring and marine terminals)). They generally address multiple hazards faced by employees performing the covered work. See, for example, 66 FR 5196 (Jan. 18, 2001) (steel erection standards address, among other hazards, risks from working under loads, dangers associated with landing and placing decking, and falls to lower levels); 62 FR 40142 (July 25, 1997) (standards covering longshoring and marine terminals address multiple hazards, including hazards associated with manual cargo handling and exposure to hazardous atmospheres); 52 FR 49592 (Dec. 31, 1987) (standard covering grain-handling facilities includes provisions related to fire and explosion hazards, as well as other safety hazards, such as the danger associated with entering bins, silos, and tanks). OSHA believes that vertical "standards can encourage voluntary compliance because they are directed to the particular problems of [an] industry" (59 FR 28596). The adoption of vertical standards is recognized as a legitimate exercise of OSHA's standard-setting authority under the OSH Act. See *Forging Indus. Ass'n* v. *Secretary of Labor* (*Noise*), 773 F.2d 1436, 1455 (4th Cir. 1985) ("[T]he Agency has determined that a particular industry should be made the subject of a vertical standard. . . . That decision was not arbitrary or capricious . . . . Nor does the use of a comprehensive vertical standard amount to a prohibited special treatment").

Although the Agency can identify the general types of hazards addressed by its vertical standards, and has done so in this rulemaking, there is no legal requirement for hazard-by-hazard significant risk findings in vertical standards. First, the DC Circuit Court of Appeals has already rejected the argument "that *Benzene* requires that the agency find that each and every aspect of its standard eliminates a significant risk faced by employees." *Ethylene Oxide,* 796 F.2d at 1502, n. 16. Once OSHA makes a general finding of significant risk, the question becomes whether the requirements of the standard are reasonably related to the standard's purpose. See, for example, *Noise,* 773 F.2d at 1447. Second, when the Supreme Court first construed the OSH Act as imposing a significant risk requirement, it spoke in terms of the Agency making findings about unsafe *workplaces,* not individual hazards. *Benzene,* 448 U.S. at 642 ("before promulgating any standard, the Secretary must make a finding that the workplaces in question are not safe [and] a workplace can hardly be considered 'unsafe' unless it threatens the workers with a significant risk of harm"). See also, for example, *id.* (framing the "significant risk" requirement as obligating OSHA "to make a threshold finding that a place of employment is unsafe—in the sense that significant risks are present and can be eliminated or lessened by a change in practices"); *Texas Indep. Ginners Ass'n* v. *Marshall,* 630 F.2d 398, 400 (5th Cir. 1980) ("[t]he Supreme Court recently ruled that the Act requires OSHA to provide substantial evidence that a significant risk of harm arises from a workplace or employment"). Third, courts have held that the OSH Act does not require the disaggregation of significant risk analyses along other lines. See, for example, *Lockout/Tagout II,* 37 F.3d at 670 (upholding OSHA's decision not to conduct individual significant risk analyses for various affected industries); *American Dental Ass'n* v. *Martin,* 984 F.2d 823, 827 (7th Cir. 1993) (OSHA is not required to evaluate risk "workplace by workplace"); *Associated Builders and Contractors,* 862 F.2d at 68 ("the significant risk requirement must of necessity be satisfied by a general finding concerning all potentially covered industries").

Requiring OSHA to make multiple, hazard-specific significant risk findings would place an unwarranted burden on OSHA rulemaking because of difficulties in specifically defining each of the hazards addressed by a vertical standard.[8] Hazards can be defined

[7] In industries in which worker exposure is less frequent than in other industries, the number of injuries or fatalities associated with the hazards covered by the final rule will most likely be less than that of industries that have a higher rate of exposure. But even for industries with low, negligible, or even no reported injuries or fatalities, the workers exposed to the hazards covered by the final rule face a "significant risk of material harm." As such, there is a significant risk to any worker of any industry exposed to the hazards covered by the final rule. See, for example, *Lockout/Tagout II,* 37 F.3d at 670 ("even in industries with low or negligible overall accident rates, the workers who engage in the operations covered by the standard face a 'significant risk of material harm'"); *Associated Builders and Contractors, Inc.* v. *Brock,* 862 F.2d 63, 67–68 (3d Cir. 1988) (where the Court ordered OSHA to expand its rule to cover additional industries, there was no need to make separate significant risk findings for those industries because "the significant risk requirement must of necessity be satisfied by a general finding concerning all potentially covered industries").

[8] Indeed, disputes over how to define hazards are commonplace in enforcement cases under the general duty clause of the OSH Act. See, for example, *Secretary of Labor* v. *Arcadian Corp.,* 20 BNA OSHC 2001 (OSHRC, Sept. 30, 2004); *Secretary of Labor* v. *Inland Steel Co.,* 12 BNA OSHC 1968 (OSHRC, July 30, 1986); *Secretary of*

broadly, for example, falling from an elevation, or more narrowly, for example, falling from an elevated aerial lift while performing tree-trimming work. The outcome of the significant risk analysis called for by EEI would be largely (and somewhat arbitrarily) dependent on where along this vast spectrum OSHA defined the relevant dangers.

OSHA reviewed the authority EEI relied on in support of the purported requirement for hazard-specific risk findings, but does not find it persuasive. First, EEI argued that the Supreme Court, in its *Benzene* decision, held that the Agency had to make separate significant risk findings for the air-contaminant and dermal-contact provisions of that standard (Ex. 0227). A close reading of the decision in that case reveals no such holding. Instead, the dermal-contact provisions in that case were remanded on the same basis that the air-contaminant provisions were rejected—namely that the provisions were not supported by any significant risk findings. See *Benzene,* 448 U.S. at 661–62. While the Court did suggest that OSHA needed to find that a prohibition on dermal contact was reasonably necessary and appropriate to address a significant risk, that is, that preventing dermal contact would reduce the overall risk associated with workplace exposure to benzene, it did not address whether a single significant risk finding could ultimately support both the dermal-contact and air-contaminant provisions in the standard. *Id.*

Second, EEI relied on the Eleventh Circuit's decision in *AFL–CIO* v. *OSHA* (*PELs*), 965 F.2d 962 (11th Cir. 1992), which vacated and remanded OSHA's Air Contaminants Standard (Ex. 0227). That rule set permissible exposure limits for more than 400 toxic substances. Although in that case the court said that OSHA needed to explain its assessment of risk for each regulated substance, that rulemaking is readily distinguished from this final rule. In *PELs,* the various regulated substances were "unrelated" and had "little [in] common." 965 F.2d at 972. Here, in contrast, the various hazards addressed by this final rule are closely related. They all arise at power generation, transmission, and distribution worksites and jointly contribute to the large number of injuries and fatalities suffered by covered workers. OSHA does not believe that the *PELs* decision limits its discretion to adopt provisions it deems reasonably necessary and appropriate to abate the existing electrocution, burn, fall, and other hazards that, together, result in covered employees being exposed to an overall workplace risk that is significant.

Finally, EEI's reliance on the Agency's ergonomics rulemaking is misplaced. EEI pointed out that OSHA's risk assessment in its ergonomics rulemaking considered only accidents that resulted from hazards covered by that standard (Ex. 0227). But this interpretation offers no support for EEI's position, as the risk assessment in this rulemaking similarly considered only injuries and fatalities that occurred during the performance of work covered by this final rule (Ex. 0080). (See also Section VI, Final Economic Analysis and Regulatory Flexibility Analysis, later in the preamble.)

Although OSHA does not agree that hazard-specific significant risk findings are necessary, the Agency believes that the record supports such findings for the critical hazards addressed in this rulemaking—namely electrocutions and electric shocks, burns from arc flashes, and falls. The Agency has found that a significant number of injuries and fatalities occur every year as a result of employee exposure to each of these hazards. (See Section VI, Final Economic Analysis and Regulatory Flexibility Analysis, later in the preamble.) Moreover, as EEI points out, "most of the hazards" addressed in this rulemaking "are already covered by the existing standards that OSHA [is] now . . . modify[ing] and supplement[ing]" (Ex. 0227). Furthermore, some of the hazards addressed by this rulemaking are already the subject of generally applicable hazard-specific horizontal standards. See, for example, 29 CFR part 1926, subpart K (electrical hazards) and subpart M (fall hazards). All of these existing standards were supported by findings of significant risk, and OSHA simply concludes that the additional provisions of this final rule are reasonably necessary and appropriate to reduce a substantial portion of the remaining significant risk at power generation, transmission, and distribution worksites.

III. Development of the Final Rule

A. History of the OSHA Standards

OSHA first adopted standards for the construction of power transmission and distribution lines and equipment in 1972 (subpart V of 29 CFR part 1926). OSHA defines the term "construction work" in 29 CFR 1910.12(b) as "work for construction, alteration, and/or repair, including painting and decorating." The term "construction" is broadly defined in § 1910.12(d) and existing § 1926.950(a)(1) to include the original installation of, as well as the alteration, conversion, and improvement of electric power transmission and distribution lines and equipment.

The general industry standard at 29 CFR 1910.269 applies to the operation and maintenance of electric power generation, transmission, and distribution installations. OSHA adopted § 1910.269 on January 31, 1994. That standard is a companion standard to subpart V of the construction standards and addresses work to which subpart V did not apply. When promulgated, § 1910.269 was also based on the latest technology and national consensus standards.

OSHA revised its Electrical Protective Equipment Standard in § 1910.137 at the same time § 1910.269 was promulgated. The revision of § 1910.137 eliminated the incorporation by reference of national consensus standards for rubber insulating equipment and replaced it with performance-oriented rules for the design, manufacture, and safe care and use of electrical protective equipment.

OSHA published a proposed rule (the subpart V proposal) on June 15, 2005 (70 FR 34822). That document proposed revising the construction standard for electric power transmission and distribution work (29 CFR part 1926, subpart V) and the general industry standards for electric power generation, transmission, and distribution work (29 CFR 1910.269). That document also proposed a new construction standard for electrical protective equipment (29 CFR 1926.97) and revisions to the general industry standards for foot protection (29 CFR 1910.136) and electrical protective equipment (29 CFR 1910.137). Public comments were originally due by October 13, 2005, but in response to requests from interested parties, including EEI, OSHA extended the comment period 90 days to January 11, 2006 (70 FR 59290, Oct. 12, 2005). OSHA held an informal public hearing beginning on March 6, 2006, and ending on March 14, 2006. After the hearing, interested parties had until May 15, 2006, to submit additional information and until July 14, 2006, to file posthearing briefs (Tr. 1415).

On October 22, 2008, OSHA reopened the record for 30 days to gather information from the public on specific questions related to minimum approach distances (73 FR 62942). EEI requested a public hearing and an additional 60 days to submit comments on the issues raised in the reopening notice (Ex. 0530). On September 14, 2009, OSHA

Labor v. *Pelron Corp.,* 12 BNA OSHC 1833 (OSHRC, June 2, 1986).

opened the record for an additional 30 days to receive more comments on minimum approach distances and announced a public hearing to be held on October 28, 2009, addressing the limited issues raised in the two reopening notices (74 FR 46958). After the hearing, interested parties had until December 14, 2009, to submit additional information and until February 10, 2010, to file posthearing briefs (Tr2. 199).

The record for this rulemaking consists of all prehearing comments, the transcripts of the two public hearings, all exhibits submitted prior to and during the two hearings, and posthearing submissions and briefs. Administrative Law Judge Stephen Purcell issued an order closing the record and certified the record to the Assistant Secretary of Labor for Occupational Safety and Health. The Agency carefully considered the entire record in preparing this final standard.

B. Relevant Consensus Standards

The National Electrical Safety Code (American National Standards Institute (ANSI) Standard ANSI/IEEE C2, also known as the NESC) contains provisions specifically addressing electric power generation, transmission, and distribution work. ANSI/IEEE C2 does not, however, address the full range of hazards covered by this final rule. It is primarily directed to the prevention of electric shock, although it does contain a few requirements for the prevention of falls and burns from electric arcs.

The American Society for Testing and Materials (ASTM) has adopted standards related to electric power generation, transmission, and distribution work. ASTM Committee F18 on Electrical Protective Equipment for Workers has developed standards on rubber insulating equipment, climbing equipment, protective grounding equipment, fiberglass rod and tube used in live-line tools, and clothing for workers exposed to electric arcs.

The National Fire Protection Association (NFPA) has adopted a standard on electrical safety for employees, NFPA 70E, *Standard for Electrical Safety in the Workplace.* Although it does not apply to electric power generation, transmission, or distribution installations, the NFPA standard contains provisions addressing work near such installations performed by unqualified employees, that is, employees who have not been trained to work on or with electric power generation, transmission, or distribution installations. It also contains methods for estimating heat energy levels from electric arcs and describes ways to protect employees from arc-flash hazards.

The Institute of Electrical and Electronic Engineers (IEEE) writes standards for electric power generation, transmission, and distribution installations and for work on those installations. Many of these standards have been adopted by ANSI. Among these IEEE standards are: IEEE Std 516, *IEEE Guide for Maintenance Methods on Energized Power-Lines,* and IEEE Std 1048, *IEEE Guide for Protective Grounding of Power Lines.*

OSHA recognizes the important role consensus standards can play in ensuring worker safety. A comprehensive list of consensus standards relating to electric power generation, transmission, and distribution work can be found in existing Appendix E to § 1910.269. OSHA proposed to add the same list as Appendix E to subpart V. OSHA considered the latest editions of all the standards listed in Appendix E in the development of this final rule. Any substantial deviations from these consensus standards are explained in Section V, Summary and Explanation of the Final Rule, later in this preamble.

C. Advisory Committee on Construction Safety and Health

Under 29 CFR parts 1911 and 1912, OSHA must consult with the Advisory Committee on Construction Safety and Health (ACCSH or the Committee), established pursuant to Section 107 of the Contract Work Hours and Safety Standards Act (40 U.S.C. 3701 *et seq.*), in setting standards for construction work. Specifically, § 1911.10(a) requires the Assistant Secretary to provide ACCSH with a draft proposed rule (along with pertinent factual information) and give the Committee an opportunity to submit recommendations. See also § 1912.3(a) ("[W]henever occupational safety or health standards for construction activities are proposed, the Assistant Secretary [for Occupational Safety and Health] shall consult the Advisory Committee.").

OSHA has a long history of consulting with ACCSH on this rulemaking. On May 25, 1995, OSHA took a draft of the proposed construction standards to ACCSH, providing the Committee with a draft of the proposal and with a statement on the need to update the standards. The Committee formed a workgroup to review the materials, and the workgroup provided comments to OSHA. The Agency gave a status report on the proposal to the Committee on August 8, 1995, and an updated draft of the proposal to ACCSH on December 10, 1999. On February 13, 2003, OSHA gave ACCSH another status report and summarized the major revisions it had made to the proposal. On May 22, 2003, OSHA provided the Committee with the same copy of the draft proposal that had been provided to the small entity representatives who were participating in the Small Business Regulatory Enforcement and Fairness Act (SBREFA) proceedings, which were being conducted at that time. OSHA also explained the major issues being raised by the small entity representatives on the draft proposal.

On May 18, 2004, ACCSH gave the Agency formal recommendations on the proposal. OSHA sought ACCSH's recommendations on the proposal generally, as well as on issues specifically related to host employer-contractor communications and flame-resistant clothing. ACCSH voted unanimously that: (1) The construction standards for electric power transmission and distribution work should be the same as the general industry standards for the same type of work; (2) it was necessary to require some safety-related communications between host employers and contractors; and (3) employees need to be protected from hazards posed by electric arcs through the use of flame-retardant clothing. ACCSH recommended, by unanimous vote, that OSHA issue its proposal, consistent with these specific recommendations.[9]

EEI suggested that OSHA had to seek additional input from ACCSH if it decided to rely on the recent work of the IEEE technical committee responsible for revising IEEE Std 516, which has not been presented to ACCSH, in developing the final rule's minimum approach-distance provisions (Tr2. 18–19). EEI is not correct. In making its assertion, EEI relies on *Nat'l Constructors Ass'n.* v. *Marshall* (*Nat'l Constructors*), 581 F.2d 960 (D.C. Cir. 1978). EEI's reliance on this case is misplaced. Although the court stated that the OSH Act and OSHA's procedural regulations (29 U.S.C. 655(b)(1); 29 CFR 1911.10(a)) place "a 'stricter' requirement on when, and how often, the agency must utilize the advisory committee procedure than does the [Administrative Procedure Act (APA)] with respect to public comment during informal rulemaking," *id.* at 970, that statement in the decision is nonprecedential *dicta.* The court did not "decide how much stricter the requirement is" because, the court

[9] ACCSH transcript for May 18, 2004, pages 224–239. This document can be viewed in the OSHA Docket Office or online at *http://www.osha.gov.*

concluded, the rule at issue did not meet "even the APA's . . . standard." *Id.* at 971 n.27. As such, the case stands, at most, for the proposition that OSHA must return to ACCSH where the final rule at issue does not meet the APA's "logical outgrowth" test.

OSHA's consultation with ACCSH in this rulemaking was consistent with the *Nat'l Constructors* decision. The *Nat'l Constructors* court stated that OSHA had to engage in further consultation with ACCSH regarding its ground-fault circuit protection standard where the final rule recognized "assured equipment grounding conductor programs" as a method of compliance, but ACCSH had never had the opportunity to comment on that particular form of employee protection. The DC Circuit concluded that the compliance program in question was neither presented to ACCSH, nor "gr[e]w logically out of anything that was presented to, or heard from, the Committee." *Id.* at 970—971. In this Subpart V rulemaking, in contrast, the basic requirement to adhere to minimum approach distances was presented to ACCSH. (See, for example, ACCSH Docket ACCSH 1995–2.) The Agency is simply refining the method used to establish the minimum approach distances [10] in light of technical progress that has been made since the proposal was reviewed by ACCSH. (For a complete discussion of the minimum approach-distance requirements and OSHA's rationale for adopting them, see the summary and explanation for final § 1926.960(c)(1), in Section V, Summary and Explanation of the Final Rule, later in this preamble.)

In any event, ACCSH had an opportunity to comment on whether OSHA should rely on the work of the IEEE committee generally. ACCSH knew that OSHA might base the minimum approach distances for subpart V on existing § 1910.269. (See, for example, Exhibit 12 in Docket ACCSH 1995–2 and Exhibit 101–X in Docket ACCSH 1995–3.) In fact, ACCSH ultimately concluded in its recommendation that the construction standards for electric power transmission and distribution work should be the same as the general industry standards for the same type of work. As existing § 1910.269's minimum approach-distance requirements were derived from IEEE Std 516 (59 FR 4320, 4382–4384 (Jan. 31, 1994)), ACCSH was on notice that the work of the IEEE 516 committee might be used by the Agency in formulating the minimum approach-distance requirements for this final rule.

That ACCSH did not specifically pass on the question of whether OSHA should derive its minimum approach-distance requirements from work done in the formulation of an IEEE standard that was not yet issued at the time of the ACCSH consultation is of no consequence. The OSH Act and OSHA's procedural regulation (29 U.S.C. 655(b)(1); 29 CFR 1911.10(a)) "make clear that the Assistant Secretary need only supply whatever information he has available to him at the time he submits his proposal to the Committee." *Nat'l Constructors,* 581 F.2d at 968. As the *Nat'l Constructors* Court recognized, "by designing the Advisory Committee option as a procedural step that must precede public notice, comment, and the informal hearing, [Congress] assumed that the Committee would not be provided with all information that the Labor Department eventually developed on the subject." *Id.* at 968 n.16. Thus, OSHA's action in the final rule is consistent with *Nat'l Constructors.*

IV. Legal Authority

The purpose of the OSH Act, 29 U.S.C. 651 *et seq.,* is "to assure so far as possible every working man and woman in the Nation safe and healthful working conditions and to preserve our human resources." 29 U.S.C. 651(b). To achieve this goal, Congress authorized the Secretary of Labor to promulgate and enforce occupational safety and health standards. 29 U.S.C. 654, 655(b), 658.

A safety or health standard "requires conditions, or the adoption or use of one or more practices, means, methods, operations, or processes, reasonably necessary or appropriate to provide safe or healthful employment and places of employment." 29 U.S.C. 652(8). A safety standard is reasonably necessary or appropriate within the meaning of 29 U.S.C. 652(8) if:

- It substantially reduces a significant risk of material harm in the workplace;
- It is technologically and economically feasible;
- It uses the most cost-effective protective measures;
- It is consistent with, or is a justified departure from, prior Agency action;
- It is supported by substantial evidence; and
- It is better able to effectuate the purposes of the OSH Act than any relevant national consensus standard.

Lockout/Tagout II, 37 F.3d at 668. In addition, safety standards must be highly protective. See, for example, *id.* at 669.

A standard is technologically feasible if the protective measures it requires already exist, can be brought into existence with available technology, or can be created with technology that can reasonably be expected to be developed. See, for example, *American Iron and Steel Inst.* v. *OSHA* (*Lead II*), 939 F.2d 975, 980 (D.C. Cir. 1991) *(per curiam).* A standard is economically feasible when industry can absorb or pass on the costs of compliance without threatening industry's long-term profitability or competitive structure. See, for example, *American Textile Mfrs. Inst.* v. *Donovan,* 452 U.S. 490, 530 n. 55 (1981); *Lead II,* 939 F.2d at 980. A standard is cost effective if the protective measures it requires are the least costly of the available alternatives that achieve the same level of protection. See, for example, *Lockout/Tagout II,* 37 F.3d at 668.

Section 6(b)(7) of the OSH Act authorizes OSHA to include among a standard's requirements labeling, monitoring, medical testing, and other information-gathering and information-transmittal provisions. 29 U.S.C. 655(b)(7). Finally, the OSH Act requires that when promulgating a rule that differs substantially from a national consensus standard, OSHA must explain why the promulgated rule is a better method for effectuating the purposes of the Act. 29 U.S.C. 655(b)(8). Deviations from relevant consensus standards are explained elsewhere in this preamble.

V. Summary and Explanation of the Final Rule

OSHA is adopting a new construction standard on electrical protective equipment, 29 CFR 1926.97, and is revising the standard on the construction of electric power transmission and distribution lines and equipment, 29 CFR part 1926, subpart V. The Agency is also revising the general industry counterparts to these two construction standards, 29 CFR 1910.137 and 1910.269, respectively. Finally, OSHA is revising its general industry standard on foot protection, 29 CFR 1910.136, to require employers to ensure that each affected employee uses protective footwear when the use of protective footwear will protect the affected employee from an electrical hazard, such as a static-discharge or electric-shock hazard, that remains after the employer takes other necessary protective measures.

This section discusses the important elements of the final rule, explains the individual requirements, and explains

[10] The basic equation for computing minimum approach distances in the final rule is the same as the one used in existing § 1910.269 and in the draft proposal submitted to ACCSH.

any differences between the final rule and existing standards. This section also discusses issues that were raised at the two public hearings, significant comments received as part of the rulemaking record, and substantive changes from the language of the proposed rule. Unless otherwise noted, paragraph references in the summary and explanation of the final rule fall under the section given in the heading for the discussion. For example, except as otherwise noted, paragraph references in V.A, Section 1926.97, Electrical Protective Equipment, are to paragraphs in final § 1926.97. Except as noted, the Agency has carried proposed provisions into the final rule without substantive change.

The final rule contains several differences from the proposal and existing §§ 1910.137 and 1910.269 that are purely editorial and nonsubstantive. For example, the Agency amended the language of some provisions to shift from passive to active voice, thereby making the standard easier to read. OSHA does not discuss explicitly in the preamble all of these differences. The purpose of these differences, unless otherwise noted, is to clarify the final standard.

A. Section 1926.97, Electrical Protective Equipment

Workers exposed to electrical hazards face a risk of death or serious injury from electric shock. According to BLS, there were 192 and 170 fatalities involving contact with electric current in 2008 and 2009, respectively (*http://www.bls.gov/iif/oshwc/cfoi/cftb0240.pdf* and *http://www.bls.gov/iif/oshwc/cfoi/cftb0249.pdf*). About half of these fatalities (89 in both years) occurred in construction (*id.*).[11]

The use of properly designed, manufactured, and cared-for electrical protective equipment helps protect employees from this risk. Therefore, OSHA is issuing final § 1926.97, Electrical protective equipment, which addresses the design, manufacture, and proper care of electrical protective equipment. In addition, OSHA is revising existing § 1910.137, which also contains provisions addressing the design, manufacture, and proper care of electrical protective equipment. For reasons described at length in this section of the preamble, OSHA concludes that the final rule will be a more effective means of protecting employees from the risk of electric shock than existing OSHA standards.

[11] Similar data are available at *http://www.bls.gov/iif/oshcfoi1.htm#2009* for each year back to 2003.

The existing requirements for electrical protective equipment in construction work are in § 1926.951(a)(1), which only applies to the construction of electric power transmission and distribution lines and equipment. However, employers throughout the construction industry use electrical protective equipment, and OSHA believes that provisions for electrical protective equipment, as specified by final § 1926.97, should apply, not only to electric power transmission and distribution work, but to all construction work. Therefore, OSHA is issuing new § 1926.97, Electrical protective equipment, which applies to all construction work.

Existing § 1926.951(a)(1) incorporates by reference the following six American National Standards Institute (ANSI) standards:

Item	ANSI Standard
Rubber insulating gloves	J6.6–1971
Rubber matting for use around electric apparatus.	J6.7–1935 (R1971)
Rubber insulating blankets.	J6.4–1971
Rubber insulating hoods	J6.2–1950 (R1971)
Rubber insulating line hose.	J6.1–1950 (R1971)
Rubber insulating sleeves.	J6.5–1971

These standards contain detailed specifications for manufacturing, testing, and designing electrical protective equipment. However, these standards have undergone several revisions since the 1971 publication date of existing subpart V and are now seriously out of date. Following is a complete list of the corresponding current national consensus standards:

ASTM D120–09, *Standard Specification for Rubber Insulating Gloves.*

ASTM D178–01 (Reapproved 2010), *Standard Specification for Rubber Insulating Matting.*

ASTM D1048–12, *Standard Specification for Rubber Insulating Blankets.*

ASTM D1049–98 (Reapproved 2010), *Standard Specification for Rubber Insulating Covers.*

ASTM D1050–05 (Reapproved 2011), *Standard Specification for Rubber Insulating Line Hose.*

ASTM D1051–08, *Standard Specification for Rubber Insulating Sleeves.*

Additionally, there are now standards on the in-service care of insulating line hose and covers (ASTM F478–09), insulating blankets (ASTM F479–06 (2011)), and insulating gloves and sleeves (ASTM F496–08), which OSHA did not incorporate or reference in existing § 1926.951(a)(1).[12]

OSHA derived proposed new § 1926.97 from these national consensus standards, but drafted it in performance terms. OSHA is carrying this approach forward into the final rule. The final rule relies on provisions from the consensus standards that are performance based and necessary for employee safety, but the final rule does not contain many of the detailed specifications from those standards. Thus, the final rule will provide greater flexibility for compliance.

BGE commented that OSHA's performance-based approach leaves the standards "vague" and creates "opportunities for unsafe practices" (Ex. 0126).

OSHA disagrees with this comment for the following reasons.

The Agency recognizes the importance of the consensus standards in defining basic requirements for the safe design and manufacture of electrical protective equipment for employees. To this end, OSHA will allow employers to comply with the final rule by following specific provisions in the consensus standards. OSHA believes that the option of following these specific provisions addresses the commenter's concern about vagueness.

However, OSHA determined that it would be inappropriate to adopt the consensus standards *in toto* in this rulemaking. First, each of the currently referenced standards has undergone several revisions since OSHA adopted the standards in existing § 1926.951(a)(1). Because of the continual process by which the consensus standards development organizations periodically revise their consensus standards, any specific editions that OSHA might adopt likely would be outdated within a few years. Additionally, since OSHA's rulemaking process is lengthy, it would not be practical for OSHA to revise its standards as often as necessary to keep pace with the changes in the consensus

[12] The relevant ASTM standards are in the record as Exs. 0048, 0049, 0050, 0051, 0066, 0067, 0068, 0069, 0070. In several cases, the version of the consensus standard in the record is older than the version listed in the preamble. However, OSHA based final §§ 1926.97 and 1910.137 only on the ASTM documents and other data in the record. The preamble lists editions of the consensus standards not in the record because OSHA evaluated them for consistency with the final rule. OSHA determined that these later ASTM standards conform to the requirements of final §§ 1926.97 and 1910.137. See the discussion of the notes following paragraphs (a)(3)(ii)(B) and (c)(2)(ix) for the significance of this determination.

standards. Final § 1926.97 is flexible enough to accommodate changes in technology, obviating the need for constant revision. Wherever possible, OSHA wrote the final rule in performance terms to allow alternative methods of compliance that provide comparable safety to employees.

Another difficulty with incorporating the consensus standards by reference is that they contain details that go beyond the scope of the OSHA standard and are not directly related to employee safety. In final § 1926.97, OSHA relied only on consensus standard provisions that are relevant to employee safety in the workplace. Furthermore, to make the requirements easier for employers and employees to use and understand, OSHA adopted language in the final rule that is simpler than that in the consensus standards. Because all relevant requirements are in the text of the regulations, employers will not need to refer to the consensus standards to determine their obligations under final § 1926.97. Although OSHA is no longer incorporating the consensus standards by reference, notes throughout the rule clarify that OSHA will deem compliance with the consensus standards listed in the notes to be compliance with the performance requirements of final § 1926.97.

OSHA notes that it recently decided not to adopt a proposed performance-based approach when it revised the design requirements contained in several personal protective equipment standards (74 FR 46350, Sept. 9, 2009). In issuing that final rule, OSHA reasoned that "widespread opposition" to, and misunderstanding of, the proposal indicated "possible misapplication . . . if adopted" (74 FR 46352).

This rationale does not apply to this rulemaking. First, there was no widespread opposition to the proposed performance-based approach in this rulemaking. A number of commenters did request that OSHA deem employers that are in compliance with all future revisions of the listed consensus standards as being in compliance with the final rule (see, for example, Exs. 0156, 0180, 0183, 0202, 0206, 0229, 0231, 0239). The Agency believes that the performance-based approach it adopts in final § 1926.97 will provide these commenters with the flexibility they requested by permitting employers to follow future versions of consensus standards so long as those future versions meet the final rule's performance-based criteria. Second, OSHA adopted a performance-based approach when it previously revised existing § 1910.137 in 1994 (59 FR 4323–4325). Several participants in the 1994 rulemaking supported a performance-based approach (59 FR 4324). Third, OSHA believes that harmonizing § 1926.97 and § 1910.137 will reduce misapplication by the regulated community and, thereby, reduce the risk of electric shock. Promulgating inconsistent standards would increase misapplication by the regulated community and, consequently, increase the risk of electric shock. Finally, OSHA has had no difficulty enforcing § 1910.137 since issuing it in 1994.

Regarding the commenters' requests that OSHA deem employers that are in compliance with all future revisions of the listed consensus standards as being in compliance with the final rule, OSHA has no basis on which to find that future revisions of the consensus standards will provide suitable guidance for compliance with the performance criteria of the final rule. Revised consensus standards may or may not meet the final rule's performance criteria. If a revised consensus standard does not satisfy this final rule's performance criteria, however, the Agency may consider compliance with that consensus standard to be a *de minimis* condition if the consensus standard clearly provides protection equal to, or greater than, the protection provided by § 1926.97.[13]

An employer seeking to rely on an updated consensus standard may evaluate for itself whether the consensus standard meets the performance criteria contained in final § 1926.97. An employer that is unsure about whether a revised consensus standard meets the OSHA standard's performance criteria may seek guidance from OSHA. If a revised consensus standard does not appear to meet the OSHA standard's performance criteria, but the employer nonetheless wants to follow the revised consensus standard, the employer should seek guidance from OSHA as to whether the Agency would consider an employer's following the revised consensus standard to be a *de minimis* condition.[14]

Some rulemaking participants asked OSHA to provide the applicable consensus standards to employers at no cost. (See, for example, Exs. 0156, 0161, 0183, 0202, 0206, 0229, 0231, 0233; Tr. 1287–1288.) For instance, Mr. Terry Williams with the Electric Cooperatives of South Carolina stated: "If OSHA is to rely on procedures that it does not describe in full, . . . the agency should provide a cost-free way for employers to review these procedures to make sure they are following them" (Ex. 0202). Mr. Don Adkins with Davis H. Elliot Construction Co. stated that the "cost of securing and reviewing these voluntary standards place[s] a financial burden on small employers" (Ex. 0156).

OSHA is rejecting these requests. The Agency stated the rule in performance-based terms, which allows employers flexibility in complying with the rules. The Agency understands that employers may want additional guidance in terms of precise procedures or detailed specifications to follow. Final § 1926.97 references relevant consensus standards to provide such additional guidance, but those standards are not mandatory.

In any event, even when OSHA incorporates consensus standards by reference, the Agency does not provide those consensus standards to employers at no cost. Many consensus standards are copyrighted documents; and, in those cases, the copyright holder has certain legal rights regarding the public distribution of those documents. Note that some consensus standards development organizations, for example, NFPA, do provide free, view-only access to their standards (*http://www.nfpa.org/itemDetail.asp?categoryID=279&itemID=18123&URL=Codes%20&%20Standards/Code%20development%20process/Online%20access*).[15] OSHA also will continue to explore other ways of informing the regulated community

[13] *De minimis* conditions are conditions in which an employer implemented a measure different from one specified in a standard, but that has no direct or immediate relationship to safety or health. The Agency does not issue citations or penalties for *de minimis* conditions, nor is the employer required to bring the workplace into compliance, that is, there are no abatement requirements. Pursuant to OSHA's *de minimis* policy, which is set forth in OSHA Instruction CPL 02–00–148 ("Field Operations Manual"), a *de minimis* condition exists when an employer complies with a consensus standard rather than with the standard in effect at the time of the inspection and the employer's action clearly provides equivalent or more effective employee protection.

[14] Note that this approach applies to the use of any consensus standard referenced in the final rule. Moreover, the same principles described with respect to subsequent versions of the consensus standards also apply to earlier versions of the consensus standards.

[15] For instance, NFPA 70E, *Standard for Electrical Safety in the Workplace,* one of the documents listed in Appendix G to Subpart V, described later in this section of the preamble, is available at *http://www.nfpa.org/aboutthecodes/AboutTheCodes.asp?DocNum=70E&cookie_test=1.* Select either the 2009 or 2012 edition from the drop-down box labeled "Edition to display" and click the link labeled "View [selected] edition online." Note that registration with NFPA is required to view the standard.

about applicable compliance obligations specified by the final rule.

Moreover, employers can often rely on the assurances of third parties that equipment or test methods meet the listed consensus standards. First, OSHA expects that employers will typically get the assurance of manufacturers that electrical protective equipment is capable of withstanding the appropriate electrical proof tests required by final paragraphs (a) and (b). In this regard, an employer can simply look for equipment labeled as meeting the listed consensus standards. Manufacturers attest, through such a label, typically required by the relevant consensus standard, that their equipment passed the requisite tests.

Second, it is OSHA's understanding that many employers, particularly small employers, do not test their own equipment to determine whether employees can use the equipment, as required by final paragraph (c). Instead, these employers send the equipment to an electrical laboratory for testing (see, for example, the testimony of Mr. Frank Brockman of Farmers Rural Electric Cooperative Corporation about the use of testing laboratories, Tr. 1301–1302). It is OSHA's understanding that, as a matter of practice, such laboratories follow the test methods in the applicable consensus standards for testing a wide range of products (see, for example, Ex. 0211).[16] To determine whether employees can use the equipment in accordance with final paragraph (c), employers can rely on the assurance of these testing laboratories that they followed the listed consensus standards, as well as the requirements of OSHA's standard.

OSHA expects that, when consensus standards development organizations revise their consensus standards, manufacturers' labels will certify that the equipment meets the latest consensus standards, and that testing laboratories will use the test methods in the latest consensus standards, rather than the consensus standards listed in the notes. OSHA is sympathetic to concerns that employers, especially small businesses, do not have the resources to purchase and check whether revised consensus standards meet the final rule's performance criteria. As discussed previously, an employer that does not have the resources to purchase and review an updated consensus standard (indeed, any employer) may request guidance from OSHA on whether compliance with an updated consensus standard would conform to this final rule or bring the employer within OSHA's *de minimis* policy.

In the final rule, OSHA reworded the headings for paragraphs (a), (b), and (c) to more accurately reflect the content of the respective paragraphs. *Paragraph (a).* Paragraph (a) of § 1926.97 addresses the design and manufacture of the following types of rubber insulating equipment: Blankets, matting, covers, line hose, gloves, and sleeves.[17] (Paragraph (b) of § 1926.97 contains general requirements for other types of insulating equipment (see the discussion of this paragraph later in this section of the preamble).) Paragraphs (a) and (c) of proposed § 1926.97 were based on existing § 1910.137(a) and (b); however, the proposal added Class 00 equipment to the classes addressed by the existing provisions to reflect the coverage of this new class of equipment in the consensus standards (Exs. 0048, 0051). This class of electrical protective equipment is used with voltages of 500 volts or less. OSHA received no comments on the proposed addition of Class 00 electrical protective equipment.

Paragraph (a)(1)(i), which is being adopted without change from the proposal, requires blankets, gloves, and sleeves to be manufactured without seams. This method of making the protective equipment minimizes the chance that the material will split. Because they are used when workers handle energized lines, gloves and sleeves are the only defense an employee has against electric shock. Additionally, the stresses placed on blankets, gloves, and sleeves by the flexing of the rubber during normal use could cause a seam to separate from tensile or shear stress.

The prohibition on seams does not apply to the other three types of electrical protective equipment covered by paragraph (a) (covers, line hose, and matting). These types of equipment generally provide a more indirect form of protection because they insulate the live parts from accidental, rather than intended, contact. Moreover, they are not usually subject to similar amounts or types of flexing and, thus, are not subject to the same stress.[18]

Paragraph (a)(1)(ii), which is being adopted with one modification from the proposal, requires electrical protective equipment to be marked to indicate its class and type. The class marking indicates the voltage with which the equipment can be used;[19] the type marking indicates whether the equipment is ozone resistant. These markings enable employees to know the uses and voltages for which the equipment is suited. This provision also permits equipment to contain other relevant markings, for example, the manufacturer's name, the size of the equipment, or a notation that the equipment is manufactured in accordance with the relevant consensus standards.

Proposed paragraphs (a)(1)(ii)(G) and (a)(1)(ii)(H) would have required rubber insulating equipment "other than matting" to be marked as Type I or Type II to indicate whether or not it was ozone-resistant. Mr. James Thomas, President of ASTM International, submitted comments recommending that the quoted language be deleted from these paragraphs because the "type classification denotes the manufacturing material being either Nonresistant to Ozone (Type I) or Resistant to Ozone (Type II) and applies to all [rubber insulating equipment], including [m]atting" (Ex. 0148).

OSHA agrees that the ASTM standards require matting to be marked with the type to indicate whether or not it is ozone-resistant, and the Agency has adopted the commenter's recommendation in the final rule.

Mr. Leo Muckerheide of Safety Consulting Services recommended that OSHA require marking the maximum use voltage on electrical protective equipment, stating:

> Many electrical workers work with multiple voltages and are infrequent users of electrical protective equipment. Therefore, expecting them to remember which class to use with which voltage is a potentially hazardous problem. This problem can be easily eliminated by having the maximum use voltage marked on the electrical protective equipment. [Ex. 0180]

OSHA rejects this recommendation. First, workers using electrical protective equipment receive training that ensures that they know which class of equipment to use on which voltage. The

[16] When a question arises as to the validity of a test method a laboratory is using, OSHA will investigate the validity of the method.

[17] The language in proposed paragraph (a) has been editorially revised in the final rule to make it clearer that the paragraph applies to *rubber insulating* equipment only.

[18] Flexing can cause different types of stress on rubber, including tensile, compression, and shear stress. Rubber insulating line hose and covers are subject to the greatest amount of flexing while employees are installing them on an energized part. However, employees install this equipment either with live-line tools or while wearing rubber insulating gloves and sleeves. Thus, when seam separation is likely, the employee is protected by other means.

Rubber insulating matting is generally laid on the floor and is not subject to the type of flexing that is likely to cause separation.

[19] The maximum use voltages for individual classes of equipment are provided in Table E–4, discussed under the summary and explanation for paragraph (c)(2)(i), *infra.*

record demonstrates that most of the workers covered by § 1910.269 and subpart V are highly trained (see, for example, Tr. 1228) and use electrical protective equipment to work on energized lines on a regular, often daily, basis (see, for example, Tr. 394, 889, 1218–1219). Furthermore, several OSHA standards require training for employees working on or near exposed energized parts, when electrical protective equipment would also be required. For instance, final §§ 1910.269(a)(2)(ii)(D) and 1926.950(b)(2)(iv) require training in the use of electrical protective equipment for qualified employees performing electric power generation, transmission, and distribution work. Paragraph (c)(2) of § 1910.333 contains a similar requirement for workers performing other types of general industry electrical work. Paragraph (b)(2) of § 1926.21 contains training requirements for workers performing construction work. Although this requirement is more general than the training requirement in this final standard, § 1926.21 requires training in OSHA standards applicable to the employee's work environment.

Second, electrical protective equipment meeting the applicable consensus standards is manufactured with the Class ratings included, but generally without labels for maximum use voltages. (See, for example, Exs. 0048, 0049, 0050, 0066, 0067, 0068.) Requiring electrical protective equipment to be marked with its maximum use voltage would likely force employers to mark the equipment themselves. OSHA believes that the permanent class-rating marking placed on electrical protective equipment by the manufacturer provides adequate information and is less likely to wear off over the useful life of the equipment than any marking put in place by an employer. Thus, the Agency concludes that a requirement for marking the maximum use voltage on electrical protective equipment is unnecessary.

Mr. Frank Owen Brockman, representing Farmers Rural Electric Cooperative Corporation, recommended that OSHA also require that the markings include the company testing the equipment, the test date, and owners of the equipment (Ex. 0173). He did not explain how including this additional information in the markings would better protect employees. Moreover, although requiring the employer to note the date equipment is tested does enhance worker protection, final paragraph (c)(2)(xii) of § 1926.97 addresses this matter by requiring the employer to certify that equipment has successfully passed the periodic testing required by the final rule and by requiring this certification to identify the equipment that passed the test and the date it was tested. OSHA agrees with Mr. Brockman that keeping workers aware of the date of last testing would enhance worker protection. Therefore, OSHA revised the language in final paragraph (c)(2)(xii) to also require that the certification required by the rule be made available to employees or their authorized representatives.

It should be noted that, although not required, the markings suggested by Mr. Muckerheide and Mr. Brockman are permitted under paragraph (a)(1)(ii)(I).

Paragraph (a)(1)(iii) requires all markings to be nonconductive and to be applied so as not to impair the insulating properties of the equipment. OSHA did not receive any comments on this provision in the proposal and has carried it forward without change into the final rule. This requirement ensures that no marking interferes with the protection to be provided by the equipment.

Paragraph (a)(1)(iv), which is being adopted without change from the proposal, requires markings on gloves to be confined to the cuff area.[20] As OSHA explained in the preamble to the proposed rule, markings in other areas could possibly wear off (70 FR 34828). Moreover, having the markings in one place will allow the employee to determine the class and type of glove quickly. Finally, as discussed later in this section of the preamble, final paragraph (c)(2)(vii) requires that rubber gloves normally be worn under protector gloves. Because a protector glove is almost always shorter than the corresponding rubber glove with which it is worn, and because the cuff of the protector glove can easily be pulled back without removal, it is easy to see markings on the cuff portion of the rubber glove beneath. Any marking provided on the rubber glove in an area outside of the cuff could not be seen with the protector glove in place.

Paragraph (a)(2) of final § 1926.97 contains electrical requirements for rubber insulating blankets, matting, line hose, gloves, and sleeves. As previously discussed, this provision uses performance language, and does not contain a lengthy discussion of specific test procedures.

Paragraph (a)(2)(i), which is being carried forward from the proposed rule, requires electrical protective equipment to be capable of withstanding the ac proof-test voltages in Table E–1 or the dc proof-test voltages in Table E–2 of the standard.[21] The proof-test voltages listed in these tables have been derived from the current ASTM standards, which also contain detailed test procedures that can be used to determine whether electrical protective equipment is capable of withstanding these voltages. As previously discussed, these details were not included in the proposed rule, and this approach is being carried forward in the final rule. Paragraph (a)(2)(i)(A) replaces those details with a performance-oriented requirement that any proof test can be used as long as it reliably indicates that the equipment can withstand the proof-test voltage involved.

Mr. Muckerheide with Safety Consulting Services stated that the standard for rubber insulating gloves, ASTM D120, lists a 280-millimeter glove instead of the 267-millimeter glove listed in Table E–1 in the proposed rule (Ex. 0180). He recommended making OSHA's standard consistent with the ASTM standard or explaining the difference in the standard.

OSHA is revising Table E–1 from the proposal in response to this comment.

OSHA based proposed Table E–1 on Table I–2 in existing § 1910.137, which, in turn, was based on the 1987 edition of ASTM D120. Section 10.3.1 of ASTM D120–1987 lists four standard lengths for Class 0 rubber insulating gloves: 279, 356, 406, and 457 millimeters. Table 2 in that edition, however, listed 267 millimeters as the shortest length glove even though the shortest standard length was 279 millimeters.

Unlike the 1987 edition of the consensus standard, the latest edition, ASTM D120–2009, rounds up the standard metric sizes. Thus, the relevant consensus standards for rubber insulating gloves list four standard sizes of 280, 360, 410, and 460 millimeters for Classes 00, 0, 1, 2, 3, and 4 gloves. The table in the 2009 edition of the consensus standard corresponding to Table 2 in the 1987 edition lists a 280-millimeter glove as the shortest one.

Based on this information, OSHA concludes that the appropriate length for the shortest glove is 280 millimeters. In addition, the Agency does not consider the difference between the 280-millimeter length recommended by Mr.

[20] The cuff area is the area near the reinforced edge of the glove.

[21] Existing § 1910.137 contains Table I–2 through Table I–6, and the proposal did not redesignate those tables. The final rule revises all of § 1910.137 so as to redesignate the tables, starting with Table I–1. Consequently, existing Table I–2 corresponds to Table I–1 in the final rule, existing Table I–3 corresponds to Table I–2 in the final rule, existing Table I–4 corresponds to Table I–3 in the final rule, existing Table I–5 corresponds to Table I–4 in the final rule, and existing Table I–6 corresponds to Table I–5 in the final rule.

Muckerheide and the 267-millimeter proposed length to be substantial. The 1987 and 2009 editions of the consensus standard each permit a glove to vary from the standard length by as much as 13 millimeters. Thus, a 280-millimeter glove can be as short as 267 millimeters. However, to ensure consistency with the latest consensus standard, OSHA is adopting, in Table E–1, both the 280-millimeter glove length in place of the proposed 267-millimeter length and the rounded-up metric sizes, as listed in the latest edition of the consensus standard.

Paragraph (a)(2)(i)(B), which is being adopted as proposed, requires the proof-test voltage to be applied continuously for 1 minute for insulating matting and 3 minutes for other insulating equipment. These times are derived from on the proof-test times given in the ASTM design standards and are appropriate for testing the design capabilities of electrical protective equipment.

Paragraph (a)(2)(i)(C), which is being adopted as proposed, requires rubber insulating gloves to be capable of withstanding the ac proof-test voltage indicated in Table E–1 of the standard after a 16-hour water soak. If rubber insulating gloves absorb water, a reduction in insulating properties will result. Electrical work is sometimes performed in the rain, and an employee's perspiration is often present while the gloves are in use, so water absorption is a critical property. The soak test is needed to ensure that rubber insulating gloves can withstand the voltage involved under these conditions.

It should be noted that the soak test is a separate test from the initial proof test. Gloves must be capable of passing both tests.

Paragraph (a)(2)(ii), which is being adopted as proposed, prohibits the 60-hertz ac proof-test current from exceeding the values specified in Table E–1 at any time during the test period. The currents listed in the table have been taken from ASTM D120–09. This provision in the final rule is important because, when an ac proof test is used on gloves, the resulting proof-test current gives an indication of the validity of the gloves' make-up, the dielectric constant of the type of material used, its thickness, and the total area under test.

Under paragraph (a)(2)(ii)(A), which is being adopted without change from the proposal, the maximum current for ac voltages at frequencies other than 60 hertz is computed from the direct ratio of the frequencies. This provision ensures that maximum current is equivalent for varying frequencies.

Paragraph (a)(2)(ii)(B), which is being adopted as proposed, specifies that gloves to be tested be filled with and immersed in water to the depth given in Table E–3 and that water be added to or removed from the glove as necessary to ensure that the water level is the same inside and outside the glove. Table E–3 is derived from ASTM D120 and is valid for the proof-test currents listed in Table E–1. During the ac proof test, a gloves is filled with, and immersed in, water, and the water inside and outside the glove forms the electrodes. The ac proof-test current is dependent on the length of the portion of the glove that is out of the water. Because the proof-test current is a function of immersion depth, it is important to specify the depth in the rule.[22]

Paragraph (a)(2)(ii)(C) requires that, after the 16-hour water soak specified in paragraph (a)(2)(i)(C), the 60-hertz proof-test current not exceed the values given in Table E–1 by more than 2 milliamperes. The allowable proof-test current must be increased for proof tests on gloves after a 16-hour water soak because the gloves absorb a small amount of water, which results in slightly increased current during the test. The final rule was derived from ASTM D120, which allows an increase in the proof-test current of 2 milliamperes. If the proof-test current increases more than 2 milliamperes, it indicates that the gloves absorbed too much water. OSHA has revised this provision in the final rule to indicate more clearly that it is a requirement rather than an exception.

Paragraph (a)(2)(iii), which is being adopted without change from the proposed rule, prohibits electrical protective equipment that has been subjected to a minimum breakdown voltage test from being used to protect employees from electrical hazards. The relatively high voltages used in testing electrical protective equipment for minimum breakdown voltage can damage the insulating material under test (even if the equipment passes). The intent of this rule is to prohibit the use of equipment that has been tested for minimum breakdown voltage under conditions equivalent to those in the ASTM standards, because minimum breakdown tests are destructive. Such tests are performed only on equipment samples that are to be discarded.

Paragraph (a)(2)(iv), which is being adopted as proposed, requires ozone-resistant material (Type II) to be capable of withstanding an ozone test that can reliably indicate that the material will resist ozone exposure in actual use. Standardized ozone tests are given in the ASTM specifications listed in the note following paragraph (a)(3)(ii)(B), and compliance with these specifications will be deemed compliance with this OSHA requirement. Around high-voltage lines and equipment, a luminous discharge, called electric corona, can occur due to ionization of the surrounding air caused by a voltage gradient that exceeds a certain critical value. The blue corona discharge is accompanied by a hissing noise and by ozone, which can cause damage to certain types of rubber insulating materials. Therefore, when there is a chance that ozone may be produced at a work location, electrical protective equipment made of ozone-resistant material is frequently used. The final rule ensures that ozone-resistant material will, in fact, be resistant to the deteriorating effects of the gas. The final rule also provides that visible signs of ozone deterioration, such as checking, cracking, breaks, and pitting, are evidence of failure to meet the requirements for ozone-resistant material.[23]

Paragraph (a)(3) addresses the workmanship and finish of electrical protective equipment. Because physical irregularities can interfere with the insulating properties of the equipment and thus reduce the protection it affords, paragraph (a)(3)(i) prohibits the presence of physical irregularities that can adversely affect the insulating properties of the equipment and that can be detected by the tests or inspections required under other provisions in § 1926.97. In the final rule, OSHA has revised the language for this provision to clarify that "harmful physical irregularities" (the term used in the proposal) means "physical irregularities that can adversely affect the insulating properties of the equipment."

OSHA recognizes that some minor irregularities are nearly unavoidable in the manufacture of rubber goods, and

[22] Atmospheric conditions might invalidate the test results at the clearances specified in Table E–3. For instance, under certain atmospheric conditions, the air between the water inside and outside the glove, which forms the two electrodes, might flash over, and thereby invalidate the test results and damage the glove. As another example, some atmospheric conditions can lead to excessive corona and the formation of ozone that ventilation cannot sufficiently dissipate. To account for these atmospheric conditions, final Table E–3 contains a note that provides that, if atmospheric conditions make these clearances impractical, the clearances may be increased by a maximum of 25 mm. (1 in.).

[23] ASTM F819–10, *Standard Terminology Relating to Electrical Protective Equipment for Workers,* which is listed in the note following paragraph (a)(3)(ii)(B), defines "ozone cutting and checking" as: "Cracks produced by ozone in a material under mechanical stress."

these imperfections may be present in the insulating materials without significantly affecting the insulation. Paragraph (a)(3)(ii), which is being adopted without change from the proposal, describes the types of imperfections that are permitted. Even with these imperfections, electrical protective equipment must be capable of passing the electrical tests specified in paragraph (a)(2).

Since paragraph (a) of final § 1926.97 is written in performance-oriented language, OSHA has included a note at the end of the paragraph stating that rubber insulating equipment meeting the requirements of the listed ASTM standards will be deemed in compliance with the performance requirements of final § 1926.97(a). This list of ASTM standards references the latest revisions of those documents. The Agency has reviewed the referenced ASTM standards and has found them to provide suitable guidance for compliance with the performance criteria of § 1926.97(a).[24]

Paragraph (b). Paragraph (b) of final § 1926.97 addresses electrical protective equipment other than the rubber insulating equipment addressed in paragraph (a). Equipment falling under this paragraph includes plastic guard equipment, insulating barriers, and other protective equipment intended to provide electrical protection to employees.

Mr. Steven Theis, representing MYR Group, requested that OSHA clarify that equipment complying with the ASTM and IEEE consensus standards mentioned in the proposal would constitute compliance with the final rule (Ex. 0162). In the proposal, OSHA pointed to ASTM F712. OSHA has reviewed ASTM F712–06 (2011) and has found that it provides suitable guidance for plastic guard equipment that employers can use to comply with final § 1926.97(b). To clarify the standard, OSHA has added a new note to paragraph (b) to indicate that OSHA will consider plastic guard equipment to conform to the performance requirements of paragraph (b) if it meets, and is used in accordance with, ASTM F712–06 (2011).

In the proposal, the Agency also pointed to IEEE Std 516, *Guide for Maintenance Methods on Energized Power Lines,* as support for the electrical criteria in proposed paragraph (b). The Agency has not referenced this consensus standard in the final rule. The IEEE standard does not contain specifications or test methods for electrical protective equipment. Instead, that consensus standard contains work methods for live-line work, including criteria for evaluating insulating tools and equipment. The Agency notes that the criteria for evaluating insulating tools and equipment specified in the IEEE standard are equivalent to the design criteria for electrical protective equipment contained in paragraph (b) in the final rule.

Paragraph (b)(1), which is being adopted without substantive change from the proposed rule, requires electrical protective equipment to be capable of withstanding any voltage that might be imposed on it. The voltage that the equipment must withstand includes transient overvoltages, as well as the nominal voltage that is present on an energized part of an electric circuit. Equipment withstands a voltage if it maintains its integrity without flashover or arc through.

Equipment conforming to a national consensus standard for that type of equipment will generally be considered as complying with this rule if that standard contains proof testing requirements for the voltage involved. In the proposal, OSHA considered accepting electrical protective equipment that was capable of passing a test equivalent to that described in ASTM F712 or IEEE Std 516 for types of equipment not addressed by any consensus standard. OSHA invited comments on whether these standards contain suitable test methods and whether equipment passing those tests should be acceptable under the OSHA standard.

Rulemaking participants generally agreed that the consensus standards provide suitable guidance for the equipment they addressed. (See, for example, Exs. 0162, 0230.) For instance, IBEW stated:

> The test methods referenced in these standards are suitable for the types of equipment they are designed for . . . [This] equipment [has] proven to be acceptable for use in this industry. [Ex. 0230]

Mr. Steven Theis of MYR Group agreed that the "specified standards contain suitable test methods" (Ex. 0162).

As noted previously, OSHA has reviewed ASTM F712–06 (2011) and found that it provides suitable guidance for compliance with final paragraph (b). The Agency has included a note in the final rule to indicate that plastic guard equipment is deemed to conform to the performance requirements of paragraph (b) if the equipment conforms to that consensus standard.

ASTM maintained that none of the ASTM standards listed in the proposed standard contain an impulse test method for transient overvoltages (Ex. 0148). The organization recommended that the final rule reflect the current referenced consensus standards.

ASTM misconstrues paragraph (b)(1) of the final rule. Paragraph (b)(1) of the final rule does not require impulse testing as ASTM alleges. Rather, it is a performance requirement that equipment be capable of withstanding both the steady-state voltages and transient (or impulse) overvoltages, to which it will be subjected. Both types of voltages can appear across the equipment during use. (See the summary and explanation for final § 1926.960(c)(1), later in this section of the preamble, for a discussion of maximum transient overvoltages that can appear on electric power lines and equipment.)

The typical test method contained in the ASTM standards for determining minimum breakdown voltage (or withstand voltage) requires testing at substantially higher voltages than those on which the equipment will be used. (See, for example, Exs. 0048, 0053, 0071.) In addition, minimum breakdown voltage testing is performed using a steadily rising ac voltage, in contrast to impulse testing, in which the overvoltage is applied for a very short period (*id.*). As noted in IEEE Std 516–2009, the existing standards for insulating tools and equipment do not address whether equipment passing the ac withstand voltage tests in those standards will also withstand transient voltage stresses (Ex. 0532). However, the IEEE standard suggests the use of a 1.3 ratio to convert ac withstand voltages to impulse, or transient, voltages (*id.*). While the IEEE standard notes that research in this area is ongoing, OSHA concludes that, in the absence of better information, employers may rely on this ratio and multiply the ac minimum breakdown voltage for protective equipment by this value to determine if that equipment can withstand the expected transient overvoltages on energized circuits. For example, insulating equipment with a minimum breakdown, or withstand, voltage of 20,000 volts is capable of withstanding a maximum transient overvoltage of 26,000 volts. This equipment would be acceptable for use to protect employees from phase-to-ground exposures on a circuit operating at 15-kilovolt, phase-

[24] See the extended discussion, earlier in this section of the preamble, on how to address future revisions of the listed consensus standards, as well as earlier versions of the listed consensus standards.

to-phase, with a 3.0 per unit maximum transient overvoltage.[25]

The Alabama Rural Electric Association of Cooperatives, requested that OSHA provide a definition of "transient overvoltage" and a suggested method of calculation (Ex. 0224).

IEEE Std 516–2009 contains the following suitable guidance (although, as stated earlier, the standard does not contain specifications or test methods for electrical protective equipment). First, the IEEE standard contains the industry-recognized definition of "transient overvoltage," which reads as follows:

> Voltage that exceeds the maximum operating line-to-ground voltage. This voltage may be the result of a transient or switching surge. [Ex. 0532 [26]]

Second, the IEEE consensus standard contains methods of determining the maximum transient overvoltage on an electric power generation, transmission, or distribution system and, as noted earlier, discusses comparing the ability of insulation equipment to withstand a transient overvoltage based on its ability to withstand voltages under more typical testing conditions (Ex. 0532). OSHA has not duplicated this information in § 1926.97. It is copyrighted information that is publicly available. However, OSHA concludes that the IEEE standard provides suitable guidance that can assist employers in complying with paragraph (b)(1) and has added a reference to that consensus standard in the note following that paragraph in the final rule.

The proposed rule invited comments on the need to set specific electrical performance values in the standard and on whether the electrical test criteria in ASTM F968 [27] (which were summarized in Table IV–1 and Table IV–2 of the preamble to the proposal (70 FR 34830)) could be applied to all types of electrical protective equipment covered by proposed paragraph (b). IBEW commented that the test values and use values in ASTM F968 are appropriate for electrically insulating plastic guard equipment, but suggested that the values are not suitable for other types of equipment because plastic guard equipment is designed to perform differently than other types of electrical protective equipment (Ex. 0230). Based on the IBEW comment, OSHA has not included in the final rule the values from Table IV–1 and Table IV–2. Moreover, since the final rule is written in performance terms, inclusion of values like those included in these tables is unnecessary.

Final paragraph (b)(2) addresses the properties of insulating equipment that limit the amount of current to which an employee is exposed. Paragraph (b)(2)(i), which is being adopted without change from the proposal, requires electrical protective equipment used as the primary insulation of employees from energized parts to be capable of passing a test for current (that is, a proof test) when subjected to the highest nominal voltage on which the equipment is to be used. Paragraph (b)(2)(ii), which is also being adopted as proposed, provides that during the test, the equipment current may not exceed 1 microampere per kilovolt of phase-to-phase applied voltage. This requirement will prevent dangerous electric shock to employees by prohibiting use of both poor insulating materials and good insulating materials that are contaminated with conductive substances (for example, fiberglass-reinforced plastic coated with a conductive finish). The limit for current has been derived from IEEE Std 516, and OSHA believes such a limit is reasonable and appropriate.

In the preamble to the proposed rule, the Agency invited comments on whether another value would better protect employees. IBEW commented on this issue as follows:

> The IEEE Standard 516 limit of 1 microampere per kilovolt of phase-to-phase applied voltage is appropriate for testing equipment used for primary insulation of employees from energized parts. This limit has apparently worked to keep inferior protective equipment of[f] the market. [Ex. 0230]

One commenter was concerned that the proposed current limit might not protect employees in the event that a fault occurred (Ex. 0126). OSHA believes that this concern is unfounded. During a fault, the voltage on a circuit typically falls, and the equipment current would fall with it. Although it is possible that transient overvoltages may occur, either during a fault on an adjacent phase or during switching operations, such overvoltages are extremely short in duration, and the possible resulting increase in equipment current should not prove life-threatening to employees.

ASTM stated that the only one of its standards that includes a 1-microampere per kilovolt requirement is ASTM F712 on plastic guard equipment (Ex. 0148). The organization recommended that OSHA limit this provision to this type of equipment.

OSHA is not adopting ASTM's recommendation. The Agency notes that ASTM F712 is not the only ASTM standard that limits equipment current to values less than 1 microampere per kilovolt of test voltage. ASTM F711, *Standard Specification for Fiberglass-Reinforced Plastic (FRP) Rod and Tube Used in Live Line Tools,* limits maximum current during the dielectric testing prescribed in that standard to values substantially less than 1 microampere per kilovolt of test voltage (Ex. 0053).[28] Further, as noted previously, this limit has been derived from IEEE Std 516. Thus, OSHA concludes that the 1-microampere limit is reasonable and appropriate.[29]

Note 1 to paragraph (b)(2), which is being adopted without substantive change from the proposal, emphasizes that this paragraph applies to equipment that provides primary insulation from energized parts, which is consistent with the plain language of paragraph (b)(2)(i). The note also clarifies that paragraph (b)(2) does not apply to equipment used for secondary insulation or equipment used for brush contact only. OSHA considers primary insulation to be the insulation that is placed directly between an employee and an energized part or, for live-line barehand work, between an employee and ground. Insulation that supplements the primary insulation, for example, a second form of insulation placed between the employee and ground (in addition to the primary insulation), is secondary insulation.

Note 2 to paragraph (b)(2), which is being adopted without change from the proposal, provides that when equipment is tested with ac voltage, the current measured during the test consists of three components: (1) Capacitive

[25] The maximum impulse voltage for this equipment is 20 kilovolts times 1.3, or 26 kilovolts. The maximum phase-to-ground use voltage for the equipment is 26 kilovolts divided by the maximum transient overvoltage in kilovolts, or 8.7 kilovolts. The phase-to-phase circuit voltage for this exposure is 8.7 kilovolts times √3, or 15 kilovolts.

[26] This is the definition of "overvoltage," for which "transient overvoltage" is a synonym.

[27] The proposal noted that there were two ASTM standards addressing plastic guard equipment, F712, which contained test methods, and F968, which contained specifications (70 FR 34829–34830, June 15, 2005). ASTM has since combined those two standards into a single one, F712–06 (2011), which contains both test methods and specifications for plastic guard equipment.

[28] Table 2 in ASTM F711–02 sets maximum leakage current for different types of rod and tube used in live-line tools (Ex. 0053). The highest value in this table is 14 microamperes. A note to the table provides that, for special applications, the maximum acceptable leakage current is twice the value listed in the table, so that 28 microamperes is the highest acceptable leakage current. The voltage applied during this test is 50 kilovolts. Thus, the maximum current is less than 1 microampere per kilovolt.

[29] It should be noted that the equipment current requirement contained in paragraph (b)(2) does not apply to rubber insulating equipment, which is covered by paragraph (a).

current caused by the dielectric properties of the equipment being tested, (2) conduction current through the equipment, and (3) leakage current passing along the surface of the equipment. The conduction current is negligible for materials typically used in insulating equipment, and the leakage current should be small for clean, dry insulating equipment. The capacitive component usually predominates when insulating equipment is tested in good condition.

OSHA expects that the tests required under final paragraphs (b)(1) and (b)(2) will normally be performed by the manufacturer during the design process and periodically during the manufacturing process. The Agency recognizes, however, that some employers might want to use equipment that is made of insulating materials but that was not intended by the manufacturer to be used as insulation. For example, a barrier made of rigid plastic may be intended for use as a general purpose barrier. An employer could test the barrier under paragraphs (b)(1) and (b)(2), and, if the equipment passes the tests, it would be acceptable for use as insulating electrical protective equipment.

Paragraph (c). Although existing construction standards do not contain provisions for the care and use of insulating equipment, OSHA believes provisions of this type can contribute greatly to employee safety. Electrical protective equipment is, in large part, manufactured in accordance with the latest ASTM standards. This would probably be the case even in the absence of OSHA regulation. However, improper use and care of this equipment can easily reduce, or even eliminate, the protection afforded by this equipment. Therefore, OSHA proposed to add new requirements for the in-service care and use of electrical protective equipment to the design standards already contained in existing § 1926.951(a)(1). These new provisions are being adopted in the final rule and will help ensure that these safety products retain their insulating properties.

Paragraph (c)(1), which is being adopted without change from the proposal, requires electrical protective equipment to be maintained in a safe and reliable condition. This general, performance-oriented requirement, which applies to all equipment addressed by final § 1926.97, helps ensure that employees are fully protected from electric shock.

Detailed criteria for the use and care of specific types of electrical protective equipment are contained in the following ASTM standards:

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.*

The requirements in final paragraph (c)(2) are derived from these standards.

Paragraph (c)(2) applies only to rubber insulating blankets, covers, line hose, gloves, and sleeves. No consensus standards address the care and use of other types of electrical protective equipment. Whereas the material design specifications for rubber insulating matting is addressed in § 1926.97(a), the in-service care of this matting is not covered by any ASTM standard or by existing § 1910.137(b)(2). This type of equipment is generally permanently installed to provide supplementary protection against electric shock. Employees stand on the matting, and they are insulated from the floor, which is one of the grounds present in the work area. This provides a degree of protection from phase-to-ground electric shock. Because this type of equipment is normally left in place after it is installed, and because it is not relied on for primary protection from electric shock (the primary protection is provided by other insulating equipment or by insulating tools), it does not need to be tested on a periodic basis and need not be subject to the same careful inspection before use that other insulating equipment must receive. It should be noted, however, that rubber insulating matting is still required to be maintained in a safe, reliable condition under paragraph (c)(1).

In final paragraph (c)(2)(i) and Table E–4, which are being adopted without substantive change from the proposal, OSHA is incorporating the margins of safety recognized in the ASTM standards by restricting the use of insulating equipment to voltages lower than the proof-test voltages given in Table E–1 and Table E–2. The rubber insulating equipment addressed in § 1926.97(a) is to be used at lower voltages than the voltages the equipment is designed to withstand. For instance, although Class 4 equipment is currently designed to be capable of withstanding voltages of up to 40 kilovolts, the maximum use voltage for such equipment is 36 kilovolts (see also, for example, ASTM F496 on the care and use of rubber insulating gloves and sleeves). The use of insulating equipment at voltages less than the actual breakdown voltage provides a margin of safety for the employee.

The maximum use voltage for class 3 equipment in Table E–4 in the final rule is being corrected to 26,500. OSHA proposed that the maximum use voltage for this class of equipment be 26,000. OSHA intended this cell in the proposed table to read 26,500, as it is in Table I–5 in existing § 1910.137 and in the applicable consensus standards, but an inadvertent error in printing resulted in the wrong number being entered in the table.

In the proposed rule, Note 1 to Table E–4 explained how the maximum use voltage of electrical protective equipment varies depending on whether multiphase exposure exists. In the general case, electrical protective equipment must be rated for the full phase-to-phase voltage of the lines or equipment on which work is being performed. This requirement ensures that employees are protected against the most severe possible exposure, that is, contact between one phase conductor and another. However, if the employee is only exposed to phase-to-ground voltage, then the electrical protective equipment selected can be based on this lower voltage level (nominally, the phase-to-phase voltage divided by $\sqrt{3}$). For example, a three-phase, solidly grounded, Y-connected overhead distribution system could be run as three phase conductors with a neutral or as three single-phase circuits with one phase conductor and a neutral each. If only one phase conductor is present on a pole, there is no multiphase exposure. If all three phase conductors are present, the multiphase exposure can be removed by insulating two of the phases or by isolating two of the phases.[30] After the insulation is in place or while the employee is isolated from the other two phase conductors, there is no multiphase exposure, and electrical protective equipment rated for the phase-to-ground voltage could be used.[31]

In the proposal, the Agency requested information about whether employees can be insulated or isolated from multiphase exposure to ensure safe use of electrical protective equipment. The

[30] Depending on the configuration of the system, an employee could be isolated from two of the phases on the pole by approaching one of the outside phase conductors and working on it from a position where there is no possibility of coming too close to the other two phase conductors. Isolation of the employee may be impossible for some line configurations.

[31] It should be noted that, until the multiphase exposure has actually been removed, the phase-to-phase voltage remains the maximum use voltage. Thus, the maximum use voltage of any insulation used to "remove phase-to-phase exposure" must be greater than or equal to the phase-to-phase voltage on the system.

comments generally supported the note to proposed Table E–4 and previously codified in Table I–5 in existing § 1910.137. (See, for example, Exs. 0155, 0175, 0177, 0227.) Mr. Charles Kelly of EEI explained:

> [T]he typical practice in the industry is for employees to cover the first phase from a position where the other phases cannot be reached. This practice isolates employees from multiphase exposure. Thus, the use of phase-to-ground voltage-rated equipment is safe.
>
> Many utilities use a class of equipment which is rated for the phase to ground voltage and rely on isolation and, to a lesser extent, cover-up equipment, to remove the potential for a multiphase exposure. Multiphase exposure is always avoided regardless of whether protective equipment (gloves or gloves and sleeves) is rated for the phase to phase voltage. Outside of rubber blankets, cover-up equipment is considered secondary protection against brush contact. Isolation from phases different than the one being worked on has always and will continue to be the primary form of defense against a phase to phase contact. The administrative control of *cover on the way in and uncover on the way out* ensures the cover-up equipment is placed from a position which isolates the worker. A worker will always cover the first phase from a position where he cannot reach the other phases. . . .
>
> The terminology for maximum use voltage in ASTM F–819 has always recognized this work practice: Thus, the ability to use phase to ground voltage rated equipment is considered by the industry to be both prudent and safe. [Ex. 0227; emphasis included in original]

Mr. Thomas Taylor of Consumers Energy agreed that these practices isolate employees from multiphase exposure so that using equipment based on the phase-to-ground voltage is safe (Ex. 0177). Ms. Salud Layton of the Virginia, Maryland & Delaware Association of Electric Cooperatives similarly believed that using isolating work practices can minimize employee exposure. She stated that, while "isolation or insulation of the employee from differing potentials in the work zone is limited to the ability of the insulating equipment to cover exposed parts," work practices can greatly minimize employee exposure (Ex. 0175).

IBEW did not specifically object to the language in the note to proposed Table E–4, but cautioned:

> To ensure a worker is isolated from contact to an energized circuit, the isolating device has to physically prohibit the worker from making contact, and the device has to maintain the electrical integrity of the energized circuit. Although the isolating device does not need to be permanent, the device should have the physical strength to ensure isolation in the case of a slip or fall, and other types of unintentional movements. [Ex. 0230]

The union also maintained that "the insulating value of the equipment would have to be . . . rated at the phase-to-phase voltage of the circuit being worked" (*id.*).

Another commenter, however, objected to the preamble statements that permitted using phase-to-ground rated insulation, stating: "Industry practice has always been to use protective equipment rated for the phase-to-phase rms voltage" (Ex. 0184).

After considering the rulemaking record on this issue, OSHA concludes that the note to proposed Table E–4 is necessary and appropriate and has carried it forward into the final rule without substantive change. The comments broadly supported the proposed note. In addition, the note is identical to Note 1 to Table I–5 of existing § 1910.137. As observed by the commenters, when multiphase exposure has been removed, by either isolating or insulating the employee, the worker is adequately protected against electric shock from the remaining phase-to-ground exposure by using phase-to-ground rated electrical protective equipment. The extent to which the note was supported contradicts the comment that industry practice is to use phase-to-phase rated electrical protective equipment. To address IBEW's concerns, OSHA emphasizes that any insulation used to remove multiphase exposure must adequately protect workers carrying out their tasks from factors that could negate the insulation's purpose. These factors include, among other things, worker movements such as reaching for tools, adjusting clothing or personal protective equipment, and slips and falls. Finally, OSHA agrees with IBEW that insulation used to protect employees from phase-to-phase exposure must be rated for the phase-to-phase exposure. After all, until this protective equipment is installed, there is phase-to-phase exposure.

Paragraph (c)(2)(ii), which is being adopted substantially as proposed, requires insulating equipment to be visually inspected before use each day and immediately after any incident that can reasonably be suspected of causing damage. In this way, obvious defects can be detected before an accident occurs. Possible damage-causing incidents include exposure to corona and direct physical damage. Additionally, rubber gloves must be subjected to an air test, along with the visual inspection. In the field, this test usually consists of rolling the cuff towards the palm so that air is entrapped within the glove. In a testing facility, a mechanical inflater is typically used. In either case, punctures and cuts can easily be detected. The note following paragraph (c)(2)(ii) indicates that ASTM F1236–96 (2012), *Standard Guide for Visual Inspection of Electrical Protective Rubber Products,* contains information on how to inspect rubber insulating equipment and descriptions and photographs of potential irregularities in the equipment.

Electrical protective equipment could become damaged during use and lose some of its insulating value. Final paragraph (c)(2)(iii), which is being adopted without substantive change from the proposal, lists types of damage that cause the insulating value of rubber insulating equipment to drop, for example, a hole, tear, puncture, or cut, or an embedded foreign object. The equipment may not be used if any of the defects listed here or in paragraph (c)(2)(iii), or any other defect that damages its insulating properties, is present.

Defects other than those listed in paragraph (c)(2)(iii) might develop during use of the equipment and could also affect the insulating or mechanical properties of the equipment. If such defects are found, paragraph (c)(2)(iv), which is being adopted without change from the proposal, requires the equipment to be removed from service and tested in accordance with other requirements in paragraph (c)(2). The results of the tests will determine if it is safe to return the items to service.

Foreign substances on the surface of rubber insulating equipment can degrade the material and lead to damage to the insulation. Paragraph (c)(2)(v), which is being adopted as proposed, requires the equipment to be cleaned as needed to remove any foreign substances.

Over time, certain environmental conditions can also cause deterioration of rubber insulating equipment. Final paragraph (c)(2)(vi), which is being adopted without substantive change from the proposal, requires insulating equipment to be stored so that it is protected from damaging conditions and substances, such as light, temperature extremes, excessive humidity, and ozone. This requirement helps the equipment retain its insulating properties as it ages. OSHA has replaced the proposed term "injurious substances and conditions" with "damaging substances and conditions" to make it clear that the equipment must be protected from substances and conditions that might damage it rather

than substances and conditions that could injure workers.

In connection with this requirement, the Agency does not believe that it is safe to store equipment on trucks for extended periods between use if such storage would expose the equipment to extremes of temperature or humidity. It may be necessary, under some circumstances, to store equipment indoors during prolonged periods when employees are not using the equipment. Workers are dependent upon electrical protective equipment for their safety, and all reasonable means of protecting it from unnecessary damage must be employed.

Rubber insulating gloves are particularly sensitive to physical damage during use. Through handling conductors and other electrical equipment, an employee can damage the gloves and lose the protection they provide. For example, a sharp point on the end of a conductor could puncture the rubber. To protect against damage, protector gloves (made of leather) are worn over the rubber gloves. Paragraph (c)(2)(vii) recognizes the extra protection afforded by leather gloves and requires their use over rubber gloves, except under limited conditions.

Proposed paragraph (c)(2)(vii)(A) provided that protector gloves are not required with Class 0 or Class 00 gloves under limited-use conditions, that is, when unusually high finger dexterity is needed for small equipment and parts manipulation. This exception is necessary to allow work to be performed on small energized parts. The Agency is adopting the proposed provision with one revision. Under paragraph (c)(2)(i) and Table E–4, which are being adopted without substantive change from the proposal, the maximum voltage on which Class 0 and Class 00 gloves can be used is 1,000 volts and 500 volts, respectively. Mr. James A Thomas, President of ASTM International, pointed out that Section 8.7.4 of ASTM F496 restricts the use of Class 00 rubber insulating gloves to voltages of 250 volts, ac, or less when they are used without protectors (Ex. 0148). Moreover, the consensus standard also includes a maximum dc voltage for Class 00 gloves used without protectors. Section 8.7.4 of ASTM F496–02a, *Standard Specification for In-Service Care of Insulating Gloves and Sleeves,* states:

> Protector gloves may be omitted for Class 0 gloves, under limited use conditions, where small equipment and parts manipulation require unusually good finger dexterity. Under the same conditions, Class 00 gloves may be used without protectors, but only at voltages up to and including 250 V a-c or 375 V d-c. Other classes of gloves may be used without protector gloves for similar conditions only where the possibility of physical damage to the gloves is unlikely and provided the voltage class of the glove used is one class above the voltage exposure. Rubber insulating gloves that have been used without protectors shall not be used with protectors until given an inspection and electrical retest. [Ex. 0051]

Based on Section 8.7.4 of ASTM F496–02a, the Agency concludes that using Class 00 gloves without protectors on voltages above 250 volts, ac, or 375 volts, dc, is considered to be unsafe by the experts on the consensus standards committee.[32] In the final rule, OSHA has therefore included a new paragraph (c)(2)(vii)(B) addressing the use of Class 00 gloves and incorporating these two voltage restrictions on the use of Class 00 gloves without protectors. Consequently, OSHA renumbered proposed paragraphs (c)(2)(vii)(B) and (c)(2)(vii)(C) as paragraphs (c)(2)(vii)(C) and (c)(2)(vii)(D), respectively, and is adopting them without substantive change.

As noted earlier, if protector gloves are not worn, there is a danger a sharp object could puncture the rubber. The resulting hole could endanger employees handling live parts because of the possibility that current could arc through the hole to the employee's hand or that leakage could develop and expose the employee to electric shock. At 250 volts, ac, or less, or 375 volts, dc, or less, for Class 00 gloves, and at 1,000 volts or less for Class 0 gloves, the danger of current passing through a hole is low, and an employee is protected against electric shock as long as the live part itself does not puncture the rubber and contact the employee's hand (59 FR 4328). Although the type of small parts, such as small nuts and washers, encountered in work covered by the exception are not likely to do this, the danger still exists (*id.*). OSHA, therefore, is adopting, without substantive change from the proposal, a note to final paragraph (c)(2)(vii)(A) that provides that persons inspecting rubber insulating gloves used under these conditions need to take extra care in visually examining them and that employees using the gloves under these conditions need to take extra care to avoid handling sharp objects.

Under paragraph (c)(2)(vii)(C), classes of rubber insulating gloves other than Class 0 and Class 00 may be used without protector gloves only if: (1) The employer can demonstrate that the possibility for physical damage to the glove is small, and (2) gloves at least one class higher than required for the voltage are used. For example, if a Class 2 glove is used at 7,500 volts or less (the maximum use voltage for Class 1 equipment pursuant to Table E–4) and the employer can demonstrate that the possibility of damage is low, then protector gloves need not be used. The final rule ensures that, under the conditions imposed by the exception, damage is unlikely, and the rule further reduces the risk to the employee by requiring thicker insulation as a measure of extra physical protection that will better resist puncture during use.[33] In addition, the consensus standard permits these classes of rubber insulating gloves to be used without protectors under the same conditions (Ex. 0051). This exception does not apply when the possibility of damage is significant, such as when an employee is using a knife to trim insulation from a conductor or when an employee has to handle moving parts, such as conductors being pulled into place.

Mr. Brockman with Farmers Rural Electric Cooperative Corporation recommended, without explanation, that there should be no exception permitting the use of rubber insulating gloves above Class 0 without protectors (Ex. 0173).

The Agency rejects this recommendation. OSHA has explained that it is safe to use Class 1 and higher rubber insulating gloves without protectors under the conditions imposed by final paragraph (c)(2)(vii)(C). OSHA notes, however, that electric power generation, transmission, and distribution work covered by § 1910.269 and subpart V will nearly always pose a substantial probability of physical damage to rubber insulating gloves worn without protectors. Thus, the exception contained in paragraph (c)(2)(vii)(C) will rarely apply when rubber insulating gloves are used for that type of work. However, electrical protective equipment covered by § 1926.97 is used outside of electric power generation, transmission, and distribution work, and there may be rare cases in these other types of work, for example, in product manufacturing or testing laboratories, in which the possibility of damage is slight.

To ensure that no loss of insulation has occurred, paragraph (c)(2)(vii)(D) prohibits any rubber insulating gloves used without protector gloves from being reused until the rubber gloves have been tested in accordance with paragraphs (c)(2)(viii) and (c)(2)(ix),

[32] ASTM F496–08 contains an identical requirement in Section 8.7.4.

[33] The thickness of the rubber increases with increasing class of rubber insulating glove (for example, from Class 0 to Class 1).

which address required test voltages and the adequacy of the test method, respectively. It should be noted that this testing is required regardless of whether the glove is Class 0 or 00, as permitted in paragraphs (c)(2)(vii)(A) and (c)(2)(vii)(B), or is Class 1 or higher, as permitted in paragraph (c)(2)(vii)(C).

The National Electrical Contractors Association (NECA) and several NECA chapters objected to the requirement to test rubber insulating gloves after use without protectors. (See, for example, Exs. 0127, 0171, 0172, 0188.) They argued that there was no safety benefit and that the increased frequency of testing would be a burden on employers. For example, NECA stated:

> The preamble doesn't include any information on electrical injuries resulting from the failure of insulated gloves used without leather protectors. Thus, requiring insulating gloves to be retested after each use without a protector is a burden upon the employer without offering any additional safety to employees. When using gloves in Classes 1–4, protectors often must be removed for reasons of manual dexterity, but the parts being worked on are fairly large which minimizes the likelihood for damage. Current techniques of inspecting and air-testing insulating gloves are sufficient to identify damaged gloves. [Ex. 0171]

Another commenter, Mr. Tom Chappell of the Southern Company, argued that an accelerated testing schedule (every 90 days instead of every 6 months) should be an acceptable alternative to testing each time a rubber insulating glove is used without a protector (Ex. 0212).

OSHA disagrees with these objections. First, the consensus standard also contains this requirement, which indicates that the consensus of expert opinion considers that the requirement provides necessary additional safety to employees (Ex. 0051). Second, a visual inspection and air test may not detect minor damage that a voltage test will. Even Mr. Chappell believes that additional testing is required to supplement the visual inspection. Third, testing on an accelerated schedule would allow such damage to go undetected until the next test, which could be as long as 89 days under Mr. Chappell's recommended testing regimen. Fourth, OSHA believes that the requirement to test rubber insulating gloves used without protectors will strongly discourage any unnecessary use of the gloves without protectors because of the expense of the test and because testing gloves shortens their useful life. Finally, any additional burden on employers is insubstantial, as employers are already required to do much of the testing specified by the final rule. In addition, existing § 1910.137(b)(2)(vii)(B) already requires gloves used without protectors to be tested before being used at a higher voltage.[34] Therefore, OSHA has carried forward proposed paragraph (c)(2)(vii)(C) into the final rule without change.

Paragraph (c)(2)(viii), which is being adopted as proposed, requires insulating equipment to be tested periodically at the test voltages and testing intervals specified in Table E–4 and Table E–5, respectively. These tests will verify that electrical protective equipment retains its insulating properties over time. Table E–4 lists the retest voltages that are required for the various classes of protective equipment, and Table E–5 presents the testing intervals for the different types of equipment. These test voltages and intervals were derived from the relevant ASTM standards.

Mr. Thomas Frank of Ameren Company objected to the inclusion of rubber insulating line hose in proposed Table E–4 and Table E–5 (Ex. 0209). He argued that the applicable consensus standard does not designate a test method for this equipment.

OSHA disagrees with this objection. Contrary to Mr. Frank's assertion, ASTM D1050, *Standard Specification for Rubber Insulating Line Hose,* does contain test methods for rubber insulating line hose (Ex. 0068).[35] Table E–5, which specifies test intervals for rubber insulating equipment, only requires testing of line hose either when the insulating value is suspect[36] or after repair. In these cases, testing is the only way of ensuring that the insulating properties of the equipment are at an acceptable level (*id.*). After all, paragraph (a)(2)(i) requires rubber insulating equipment to be capable of passing electrical tests. When the insulating value of the equipment is suspect, or when the equipment has been altered, as it will have been during any repair, there is simply no way other than testing to determine whether the equipment retains the required insulating value. Therefore, OSHA has carried proposed Table E–4 and Table E–5 into the final rule without substantive change.

Paragraph (c)(2)(ix), which is being adopted without change from the proposal, establishes a performance-oriented requirement that the method used for the tests required by paragraphs (c)(2)(viii) and (c)(2)(xi) (the periodic and postrepair tests, respectively) give a reliable indication of whether the electrical protective equipment can withstand the voltages involved. As this is a performance-oriented standard, OSHA does not spell out detailed procedures for the required tests, which will obviously vary depending on the type of equipment being tested.

Following paragraph (c)(2)(ix) is a note stating that the electrical test methods in various listed ASTM standards on rubber insulating equipment will be deemed to meet the performance requirement. As mentioned earlier, this note does not mean that OSHA is adopting the listed ASTM standards by reference. In enforcing § 1926.97(c)(2)(ix), the Agency will accept any test method that meets the performance criteria of the OSHA standard.

Once equipment has undergone in-service inspections and tests, it is important to ensure that any failed equipment is not returned to service. Final paragraph (c)(2)(x), which is being adopted without change from the proposal, prohibits the use of electrical protective equipment that failed the required inspections and tests. Paragraph (c)(2)(x) does, however, list the following acceptable means of eliminating defects and rendering the equipment fit for use again.

The final standard permits defective portions of rubber line hose and blankets to be removed in some cases. The result would be a smaller blanket or a shorter length of line hose. Under the standard, Class 1, 2, 3, and 4 rubber insulating blankets may only be salvaged by severing the defective portions of the blanket if the resulting undamaged area is at least 560 millimeters by 560 millimeters (22 inches by 22 inches). For these classes, smaller sizes cannot be reliably tested using standard test methods. Although the standard does not restrict the size of Class 0 blankets, OSHA believes that practical considerations in testing and using Class 0 blankets will force employers to similarly limit the size of these blankets when they have been repaired by cutting out a damaged portion.

[34] Existing § 1910.137(b)(2)(vii)(B) only requires gloves to be tested before being used on a higher voltage. The final rule adopts the proposed revision to this requirement so that rubber insulating gloves used without protectors must be tested before reuse after any use without protector gloves. For the purposes of §§ 1926.97(c)(2)(vii)(D) and 1910.137(c)(2)(vii)(D), "reuse" means any use after the limited use permitted without protector gloves.

[35] Both the 1990 edition of ASTM D1050 referenced in the note to existing § 1910.137(b)(2)(ix) and the 2005 edition referenced in the note to final § 1926.97(c)(2)(ix) contain test methods for rubber insulating line hose.

[36] The insulating value of rubber insulating equipment is suspect when the inspection required by final paragraph (c)(2)(ii) leads to questions about the quality of the insulation or uncovers any damage to the insulating equipment.

Obviously, gloves and sleeves cannot be repaired by removing a defective portion; however, the final standard permits patching rubber insulating gloves and sleeves if the defects are minor. Blankets may also be patched under certain circumstances. Moreover, rubber insulating gloves and sleeves with minor surface blemishes may be repaired with a compatible liquid compound. In all cases (that is, whether a patch is applied or a liquid compound is employed), the repaired area must have electrical and physical properties equal to those of the material being repaired.

Repairs performed in accordance with the standard are unlikely to fail because the rule requires the use of compatible patches or compatible liquid compounds and requires the repaired area to have electrical and physical properties equal to those of the surrounding material. However, to minimize the possibility that glove repairs will fail, repairs to rubber insulating gloves outside the gauntlet area (that is, the area between the wrist and the reinforced edge of the opening) are not allowed. OSHA stresses that the final rule does not permit repairs in the working area of the glove, where the constant flexing of the rubber during the course of work could loosen an ill-formed patch. A failure of a patch or liquid compound in this area of the glove would likely lead to injury very quickly. On the other hand, the gauntlet area of rubber insulating gloves is not usually in direct contact with energized parts. If a patch fails in this area, a worker is much less likely to be injured.

Farmers Rural Electric Cooperative Corporation recommended, without explanation, that OSHA not permit patching of rubber insulating gloves and sleeves (Ex. 0173). OSHA rejects this recommendation. OSHA has explained that it is safe only to patch insulating gloves and sleeves under the conditions imposed by final paragraph (c)(2)(x)(D).

Once the insulating equipment has been repaired, it must be retested to ensure that any patches are effective and that there are no other defects present. Such retests are required under paragraph (c)(2)(xi), which is being adopted without change from the proposal.

Employers, employees, and OSHA compliance staff must have a method of determining whether the tests required under this section have been performed. Paragraph (c)(2)(xii) requires this determination to be accomplished by means of certification by the employer that equipment has been tested in accordance with the standard. The certification is required to identify the equipment that passed the test and the date it was tested. Typical means of meeting this requirement include logs and stamping test dates on the equipment. A note following paragraph (c)(2)(xii) explains that these means of certification are acceptable. As explained under the summary and explanation for paragraph (a)(1)(ii) earlier in this section of the preamble, the final rule, unlike the proposal, includes an explicit requirement that employers make this certification available upon request to employees and their authorized representatives. OSHA has also clarified the requirement to indicate that the certification records must be made available upon request to the Assistant Secretary for Occupational Safety and Health.

B. Subpart V, Electric Power Transmission and Distribution

OSHA is revising subpart V of its construction standards. This subpart contains requirements designed to prevent deaths and other injuries to employees performing construction work on electric power transmission and distribution installations. OSHA based the revision of subpart V primarily on the general industry standard at § 1910.269, *Electric power generation, transmission, and distribution,* which the Agency promulgated in January 1994. The final standard revises the title of subpart V from "Power Transmission and Distribution" to "Electric Power Transmission and Distribution" to make it clear that the subpart addresses "electric" power transmission and distribution (and not mechanical power transmission) and to match the title of § 1910.269 more closely.

1. Section 1926.950, General

Section 1926.950 defines the scope of final subpart V and includes, among other provisions, general requirements for training and the determination of existing workplace conditions. Paragraph (a)(1)(i) of final § 1926.950 is adopted without change from proposed § 1926.950(a)(1) and sets the scope of revised subpart V. This paragraph has been taken largely from existing § 1926.950(a) and (a)(1). Subpart V applies to the construction of electric power transmission and distribution installations. In accordance with existing § 1926.950(a)(1) and § 1910.12(d), paragraph (a)(1)(i) of final § 1926.950 provides that "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.

As noted in Section II, Background, earlier in this preamble, rulemaking participants generally supported OSHA's goal of providing consistency between § 1910.269 and subpart V. However, many commenters urged the Agency to combine § 1910.269 and subpart V into a single standard applicable to all electric power generation, transmission, and distribution work. (See, for example, Exs. 0099, 0125, 0127, 0146, 0149, 0151, 0152, 0153, 0156, 0159, 0161, 0164, 0172, 0175, 0179, 0180, 0183, 0186, 0188, 0202, 0206, 0225, 0226, 0229, 0231, 0233, 0239, 0241, 0401; Tr. 291–294, 542–543, 1235–1236, 1282–1283, 1322, 1332.) These rulemaking participants argued that several benefits would result from combining § 1910.269 and subpart V into a single standard, including:

- Lessening confusion—a single standard would eliminate questions about whether work is construction or maintenance and ensure uniform interpretations for all generation, transmission, and distribution work (see, for example, Exs. 0146, 0151, 0152, 0156, 0175, 0183, 0202, 0233);
- Facilitating compliance and reducing costs—under a single standard, employers would be able to train workers in a single set of rules rather than one set for construction and another set for maintenance (Tr. 293–294); and
- Eliminating the need to maintain and update two standards over time (see, for example, Exs. 0127, 0149, 0152, 0179).

OSHA is rejecting these recommendations to combine § 1910.269 and subpart V into a single standard. First, OSHA does not believe that employers will have to maintain separate sets of rules for construction and maintenance. Because the final rule largely adopts identical requirements for construction and maintenance, OSHA expects that employers will be able to fashion a single set of rules, consistent with both § 1910.269 and subpart V, that apply regardless of the type of work being performed. In the final standard, OSHA is adopting different rules in a few cases, based on fundamental differences between the other construction standards in part 1926 and the general industry standards in part 1910. For example, § 1910.269 and subpart V reference the general industry and construction standards on medical services and first aid in §§ 1910.151 and 1926.50, respectively. These general industry and construction standards set slightly different requirements for

medical services and first aid. Similarly, § 1910.269 and subpart V separately reference the general industry and construction standards on ladders. The differences between the construction and general industry standards that may apply to electric power generation, transmission, and distribution work go well beyond the few examples described here. It is beyond the reach of this rulemaking to unify all of the different general industry and construction standards that apply to electric power generation, transmission, and distribution work. Consequently, any employer that performs both general industry and construction work will need to ensure compliance with applicable provisions in both part 1910 and part 1926. Even if OSHA were to adopt one electric power generation, transmission, and distribution standard, employers would still be faced with differences between other requirements in the general industry and construction standards.

Second, commenters' concerns over differences in language and interpretation are largely unfounded. As noted in the preamble to the proposal, one of the primary goals of this rulemaking is to make the requirements for construction and maintenance consistent with one another. The Agency will take steps to ensure that interpretations of identical requirements in the two standards are the same. Toward this end, the Agency is including a note to final § 1926.950(a)(1)(i) to indicate that an employer that complies with § 1910.269 generally will be considered in compliance with the requirements in subpart V. There is a minor exception for provisions in subpart V that incorporate by reference requirements from other subparts of part 1926. For those provisions of subpart V, the employer must comply with the referenced construction standards; compliance with general industry standards referenced in comparable provisions of § 1910.269 will not be sufficient. The new note to § 1926.950(a)(1) should allay the concerns of commenters about potentially inconsistent interpretations of identical requirements in § 1910.269 and subpart V. The note should also assure employers that they can adopt uniform work practices for the construction, operation, and maintenance of electric power generation, transmission, and distribution installations with regard to these requirements.

Ameren Corporation was concerned that OSHA would "make significant and costly changes to the current 1910.269 standard without adequately providing the opportunity for utilities to study and comment on the impact to these changes" (Ex. 0209). The company requested that the Agency provide the utility industry with an opportunity to comment on any changes to existing § 1910.269 that were not identified in the proposal.

OSHA does not believe additional notice and opportunity for comment is necessary for any of the revisions to § 1910.269 being made in this final rule. In the preamble to the proposed rule, the Agency stated:

> OSHA expects that final Subpart V will differ from proposed Subpart V because of changes adopted based on the rulemaking record. When the final rule is published, the Agency intends to make corresponding changes to § 1910.269 to keep the two rules the same, except to the extent that substantial differences between construction work and general industry work warrant different standards. [70 FR 34892]

The Agency met this objective in this final rule. OSHA concludes that any revisions to existing § 1910.269 adopted in the final rule are based on the record considered as a whole and are a logical outgrowth of the rulemaking record.

Mr. Anthony Ahern with Ohio Rural Electric Cooperatives recommended that OSHA combine §§ 1910.137 and 1926.97, or simply reference § 1910.137, instead of creating a new section on electrical protective equipment in the construction standards (Ex. 0186).

OSHA rejects this request. New § 1926.97 applies to all of construction, not just electric power generation, transmission, and distribution work. Final § 1926.97 imposes no additional burden on employers beyond what would apply under § 1910.137. Duplicating the § 1910.137 requirements in part 1926 meets the needs of construction employers and employees for ready access to the protective equipment standards that are applicable to their work.

Ms. Salud Layton of the Virginia, Maryland & Delaware Association of Electric Cooperatives objected to the word "improvement" in proposed § 1926.950(a)(1) (Ex. 0175). Ms. Layton also expressed concern about a part of the preamble to the proposed rule in which OSHA used the term "repair" to describe construction activities (*id.*). She commented:

> As defined in the regulation, "construction" includes "erection of new transmission and distribution lines and equipment, and the alteration, conversion, and improvement of existing electric transmission and distribution lines and equipment.["] While "alteration" and "conversion" can be construed as construction activities, the term "improvement" is too broad. Many maintenance activities are considered improvements. Additionally, the preamble uses the term "repair" in describing construction activities. Repairs are typically considered maintenance activities in our industry, further complicating this issue. [*id.*]

OSHA considered Ms. Layton's comments, but decided to adhere to its longstanding practice of treating "improvements" and "repairs" as construction. The term "improvement" has been a part of the definition of construction work under Subpart V for decades. Furthermore, as noted earlier, this definition is codified in 29 CFR 1910.12(d). In addition, removing the term would have no practical effect on the definition, as all improvements are "alterations," a term to which she did not object. OSHA has consistently treated "repairs" as construction work as well. See § 1910.12(b) ("*Construction work* means work for construction, alteration, and/or repair. . . ."). OSHA recognizes that there may not always be a clear distinction between construction repair and general industry maintenance and has provided clarification in numerous letters of interpretation, including the Agency's Memorandum for Regional Administrators dated August 11, 1994.[37] That memorandum explains construction work as follows:

> [C]onstruction work is not limited to new construction. It includes the repair of existing facilities. The replacement of structures and their components is also considered construction work.
>
> * * * * *
>
> There is no specified definition for "maintenance", nor a clear distinction between terms such as "maintenance", "repair", or "refurbishment." "Maintenance activities" can be defined as making or keeping a structure, fixture or foundation (substrates) in proper condition in a routine, scheduled, or anticipated fashion. This definition implies "keeping equipment working in its *existing* state, i.e., preventing its failure or decline." However, this definition, (taken from the directive on confined spaces) is not dispositive; and, consequently, determinations of whether a contractor is engaged in maintenance operations rather than construction activities must be made on a case-by-case basis, taking into account all information available at a particular site. [Emphasis included in original.]

(See also, for example, letter to Raymond Knobbs (Nov. 18, 2003) and letter to Randall Tindell (Feb. 1, 1999).[38]) In addition, the Occupational

[37] This document is available at *http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=21569.*

[38] The Knobbs and Tindell letters are available at: *http://www.osha.gov/pls/oshaweb/owadisp.show_*

Safety and Health Review Commission (OSHRC) has addressed this issue. (See, for example, *Gulf States Utilities Co.*, 12 BNA OSHC 1544 (No. 82–867, Nov. 20, 1985).) In any event, one of OSHA's primary objectives in this rulemaking is to make § 1910.269 and subpart V more consistent with each other. Therefore, going forward, the distinction between construction and maintenance will be of much less significance to employers covered by these standards. Even Ms. Layton recognized that her concern about the definition of construction was only relevant "[i]f the regulations are not the same" (Ex. 0175). The proposed definition of "construction" in § 1926.950(a)(1) is, therefore, being carried forward into the final rule without change.

Mr. Kenneth Stoller of the American Insurance Association inquired about the applicability of the revised standards to insurance industry employees, stating:

> AIA is concerned that the new contractor obligations contemplated by the proposal with respect to training, reporting, record-keeping and personal protective equipment may unintentionally apply to insurance industry employees, whose only obligation is to inspect—but not work on—some of the electrical equipment in question. While our members are neither electrical utilities nor electrical construction companies, some of their commissioned inspectors are required to visit and inspect equipment that is both energized and open. In addition, some state laws identify certain equipment (such as pressure vessels) located within close proximity to energized and open electrical apparatus that must be inspected periodically.
>
> Subjecting insurers to these new requirements would require individual companies to spend tens of thousands of dollars per year for additional training and equipment, notwithstanding the fact that the proposal's preamble indicates that these obligations should only apply to entities performing maintenance and repairs, not simply inspections. Accordingly, we recommend that the proposal be amended to explicitly exempt insurance industry employees from any obligations it places on contractors. [Ex. 0198]

OSHA considered this comment, but will not be exempting insurance industry employees from the final rule. Existing § 1910.269 already covers inspections of electric power generation, transmission, and distribution installations performed by insurance company workers as work "directly associated with" these installations. In this regard, existing § 1910.269(a)(1)(i)(D) states that "[§ 1910.269 applies to:] (D) Work on or directly associated with [electric power generation, transmission, and distribution and other covered] installations. . . ." OSHA, therefore, interprets existing § 1910.269(a)(1)(i)(D) as applying to inspections conducted by insurance company employees because the purpose of these inspections is to assure the safety of these installations and employees working on or near them. Insurance inspections are similar to inspections conducted by electric utilities and their contractors. The preamble to the 1994 final rule adopting § 1910.269 specifically listed "inspection" as an activity covered by that standard (59 FR 4333). Section 1910.269 applies to this type of work without regard to the industry of the employer that has employees performing the inspections.[39] Thus, existing § 1910.269 covers this work as it pertains to general industry and will continue to cover this work after the final rule becomes effective. However, insurance inspections may fall under subpart V, instead of § 1910.269, to the extent the inspections are construction work. Whether an insurance inspection constitutes construction depends on the characteristics of the work performed. (See, for example, *CH2M Hill, Inc.* v. *Herman*, 192 F.3d 711 (7th Cir. 1999).)

OSHA does not believe that the final rule will impose substantial additional costs on the insurance industry. Existing § 1910.269 currently covers the vast majority of insurance inspections on electric power installations. Of the new provisions this final rule is adding to § 1910.269, the ones that impose the greatest costs on all employers are unlikely to impose significant economic burdens on inspections conducted by insurance industry workers. First, the minimum approach distance and arc-flash-protection requirements usually will not apply to the insurance industry because insurance industry inspectors will almost never be qualified employees (see final §§ 1910.269(l) and 1926.960).[40]

Second, the host-contractor provisions in §§ 1910.269(a)(3) and 1926.950(c) should not impose significant costs on the insurance industry. As explained in Section VI, Final Economic Analysis and Regulatory Flexibility Analysis, later in this preamble, OSHA estimated the costs of the host-contractor provisions on a per-project basis; that is, employers will incur costs once for each project. OSHA believes that its estimate of the number of projects fully accounts for projects that involve inspections, including insurance inspections, of electric power generation, transmission, and distribution installations, though OSHA allocated the costs to contract employers generally. OSHA anticipates that the number of insurance inspections will be a small fraction of the number of overall projects. If 1 in every 1,000 projects involves an insurance inspection, then the total costs related to employers' complying with the host-contractor provisions for insurance inspections would be less than $20,000 per year, half of which host employers would bear. The Agency deems such costs an inconsequential portion of the overall costs of the final rule and not significant for the insurance industry.

Third, OSHA does not believe that insurance inspections will typically involve employees working from aerial lifts or on poles, towers, or similar structures covered by the personal protective equipment requirements in final §§ 1910.269(g)(2)(iv)(C) and 1926.954(b)(3)(iii). Mr. Stoller's lone example of work potentially affected by the final rule, the inspection of pressure vessels, is not generally covered by those provisions, which primarily affect work involving overhead transmission and distribution lines. OSHA is unaware of any other insurance inspection work that would involve employees working from aerial lifts or on poles, towers, or similar structures. Even if such inspections are taking place, they should be rare, and the Agency deems costs associated with such inspections an inconsequential portion of the overall costs of the final rule, and inconsequential as well for the insurance industry.

Paragraph (a)(1)(ii) of final § 1926.950 provides that subpart V does not apply to electrical safety-related work practices for unqualified employees. Electrical safety-related work-practice requirements for these employees are contained in other subparts of part 1926, including subparts K, N, and CC. For example, § 1926.416(a)(1) in subpart K prohibits employers from permitting an employee to work in such proximity to any part of an electric power circuit that the employee could contact the electric power circuit in the course of work, unless the employee is protected against

document?p_table=INTERPRETATIONS&p_id=24789 and *http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=22687*, respectively.

[39] See the letter of interpretation dated June 9, 1999, to Mr. G. William Doody, which is available at *http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=22749*.

[40] According to final § 1910.269(a)(1)(ii)(B), § 1910.269 does not apply to electrical safety-related work practices covered by Subpart S. Subpart S applies to work performed by unqualified persons on, near, or with electric power generation, transmission, and distribution installations (see § 1910.331(b)).

electric shock by deenergizing the circuit and grounding it or by guarding it effectively by insulation or other means. Deenergizing circuits and insulating them from employees protects unqualified employees from electric shock. By contrast, subpart V, in final § 1926.960(b)(1)(i), permits only qualified employees to work on or with exposed energized lines or parts of equipment. Final § 1926.960(c)(1)(iii) requires the employer to ensure that no employee approaches or takes any conductive object closer to exposed energized parts than the minimum approach distances, established by the employer under final § 1926.960(c)(1)(i), unless the employee is insulated from the energized part (for example, with rubber insulating gloves and sleeves), or the energized part is insulated from the employee and from any other conductive object at a different potential, or the employee is performing live-line barehand work in accordance with § 1926.964(c).

Subpart CC generally requires employers to ensure that employees maintain minimum clearances when operating cranes or derricks near overhead power lines. Paragraph (a)(6) of § 1926.600 also generally requires minimum clearances when mechanical equipment is operated near overhead power lines. In part because subpart V establishes requirements for qualified employees operating mechanical equipment, § 1926.959(d)(1) of this final rule generally requires mechanical equipment, including cranes and derricks, to maintain minimum approach distances that are significantly less than the minimum clearance distances in either § 1926.600(a)(6) or subpart CC.

OSHA did not expressly propose to exempt electrical safety-related work practices used by unqualified employees from subpart V; however, the preamble to the proposal made it clear that subpart V's requirements did not apply to electrical safety-related work practices used by unqualified employees. (See, for example, 70 FR 34857.) Specifically, the Agency stated: "The general approach taken in the proposed revision of Subpart V is to provide safety-related work practices for qualified employees to follow when they are performing electric power transmission and distribution work. Safe work practices for unqualified employees are not addressed in proposed Subpart V . . ." (70 FR 34857). Information in the record shows that the requirements in subpart V are not sufficiently protective for unqualified employees. (See, for example, Exs. 0077, 0134.) For example, NFPA 70E contains electrical safety-related work practice requirements to protect unqualified employees from electrical hazards posed by electric power transmission and distribution installations (Ex. 0134).[41] The consensus standard requires unqualified employees to maintain minimum approach distances that are substantially greater than the minimum approach distances in Subpart V.

OSHA designed subpart V to mirror the requirements in § 1910.269. Existing § 1910.269(a)(1)(i)(A), which is being adopted in the final rule without substantive change, provides that § 1910.269 applies to "[p]ower generation, transmission, and distribution installations, including related equipment for the purpose of communication or metering, which are accessible only to qualified employees." Existing (and final) § 1910.269(a)(1)(ii)(B) explicitly excludes "electrical safety-related work practices . . . covered by subpart S of this part" from coverage. According to § 1910.331(b), subpart S covers electrical safety-related work practices for unqualified employees working on, near, or with installations for the generation, transmission, or distribution of electric energy. Thus, § 1910.269 does not apply to electrical safety-related work practices for unqualified employees.

In conclusion, OSHA notes that the electrical safety-related work practices required by Subpart V do not provide sufficient protection for unqualified employees. Therefore, Subpart V does not and should not cover such work practices. The final rule, in § 1926.950(a)(1)(ii), expressly clarifies that Subpart V does not cover electrical safety-related work practices for unqualified employees.

Paragraph (a)(2) of final § 1926.950, which is being adopted without change from the proposal, explains that subpart V applies in addition to all other applicable standards contained in part 1926. This paragraph also provides that employers doing work covered by subpart V are not exempt from complying with other applicable provisions in part 1926 by the operation of § 1910.5(c). Paragraph (a)(2) also clarifies that specific references in subpart V to other sections of part 1926 are provided for emphasis only. In accordance with this provision, all construction industry standards continue to apply to work covered by subpart V unless there is an applicable exception in subpart V or elsewhere in part 1926. For example, § 1926.959(a)(2) requires the critical safety components of mechanical elevating and rotating equipment to be visually inspected before each shift. This provision does not supersede § 1926.1412(d), which details specific requirements for the visual inspection of cranes each shift by a competent person. In a change that OSHA considers nonsubstantive, § 1910.269(a)(1)(iii) is being amended to include language equivalent to that in § 1926.950(a)(2).

Subpart V has never applied to work on electric power generation installations. Proposed § 1926.950(a)(3) provided that § 1910.269 would cover all work, including construction, involving electric power generation installations. In the preamble to the proposal, the Agency explained that the construction of an electric power generation station normally poses only general construction hazards, that is, hazards not addressed by subpart V (70 FR 34833). OSHA recognized, however, the following two exceptions to this conclusion: (1) during the final phase of construction of a generating station, when electrical and other acceptance testing of the installation is being performed, and (2) during "reconstruction," when portions of the generating station not undergoing construction are still in operation (*id.*). In both of these scenarios, construction work at a generation station exposes workers to hazards akin to those posed by the operation and maintenance of a generation plant. Because the Agency believed that these two operations were more like general industry work than construction, it deemed it appropriate for employers to follow § 1910.269 in those situations (*id.*). Rather than repeat the relevant portions of § 1910.269 in subpart V, OSHA proposed that § 1910.269 apply to all work involving electric power generation installations.

The Agency requested comments on whether § 1910.269 should apply to all work involving electric power generation installations, as proposed, or whether instead the relevant requirements from § 1910.269 should be contained in final subpart V for purposes of construction work involving electric power generation installations. OSHA received numerous responses to this request. (See, for example, Exs. 0125, 0127, 0130, 0149, 0151, 0155, 0159, 0162, 0163, 0172, 0177, 0179, 0186, 0188, 0201, 0208, 0209, 0212, 0213, 0227, 0230.) Commenters largely supported OSHA's proposed approach and the language making § 1910.269 applicable to all work involving electric power generation installations. For

[41] See NFPA 70E–2004, Section 110.1, which sets the scope for Article 110, General Requirements for Electrical Safety-Related Work Practices (Ex. 0134).

example, Mason County Public Utility District 3 commented: "We believe the proposed language referencing 1910.269 for all work involving electric power generation installations should be adopted" (Ex. 0125). Siemens Power Generation responded similarly, explaining, "Subpart V should not apply to the electric power generation installations [because m]aintenance in these installations is covered adequately by 1910.269 and construction is covered adequately by general construction requirements" (Ex. 0163). In addition, Mr. Tom Chappell of Southern Company agreed with OSHA that "[a]pplying 1910.269 during the 'final phase of construction' or 'reconstruction work' would be preferable to recreating the same requirements in Subpart V" (Ex. 0212).

On the other hand, NIOSH suggested that it "would be less burdensome" for employers if the relevant requirements for construction at generation installations were incorporated in subpart V (Ex. 0130). In addition, MYR Group was concerned that OSHA's proposed approach could lead to confusion, explaining:

> [A]pplying part 1910 electrical standards [to construction work involving generation installations] would cause confusion as to whether other applicable general industry or construction standards would govern the remaining aspects of such work. Thus, OSHA's proposal—based on an alleged simplification—does itself create confusion. [Ex. 0162]

OSHA considered these comments, but does not believe that applying § 1910.269 to construction involving generation installations is likely to result in any heavy burdens or confusion. OSHA's construction standards (29 CFR part 1926) apply to general construction activities performed at generation installation sites. As previously explained, § 1910.269 generally will not apply to the original construction of a generating station until the final phase of construction, when many of the provisions in § 1910.269 become applicable. For example, in the early construction phases, the generation installation would contain no energized circuits, so the provisions for working near energized parts in § 1910.269(l) would not apply. Similarly, in the construction of a coal-fired generating station, the requirements in § 1910.269(v)(11) on coal handing would have no application until coal is present. To the extent an employer is performing late-stage construction or reconstruction of a generation installation and § 1910.269 applies, the provisions of § 1910.269 supplement, but do not replace, any relevant general construction requirements. (See §§ 1910.269(a)(1)(iii) and 1926.950(a)(2).) For example, the training requirements in § 1910.269(a)(2) apply in addition to any applicable training requirements in part 1926.[42]

With this additional clarification and the support of most of the commenters who provided feedback on this issue, the Agency is adopting proposed § 1926.950(a)(3) as it relates to the construction of electric power generation installations.[43]

Another coverage issue raised in the proposal relates to line-clearance tree trimming, which is currently addressed in § 1910.269.[44] (See existing § 1910.269(a)(1)(i)(E).) As OSHA explained in the preamble to the proposal, line-clearance tree trimming is not normally performed as part of the construction of electric power transmission or distribution installations (70 FR 34833). One exception occurs when trees are trimmed along an existing overhead power line to provide clearance for a new transmission or distribution line that is under construction (*id.*). While this type of work by line-clearance tree trimmers is properly classified as construction work, it shares many similarities with the work done by line-clearance tree trimmers that is properly classified as general industry work.[45] For this reason, as well as for ease of compliance and enforcement, proposed § 1926.950(a)(3) provided that § 1910.269 would apply to all line-clearance tree-trimming operations, even those that might be considered construction. OSHA requested comments on whether § 1910.269 should apply to all work involving line-clearance tree trimming, as proposed, or whether the relevant requirements from § 1910.269 should be contained in subpart V.

The Agency received a handful of comments on this issue. (See, for example, Exs. 0175, 0186, 0201, 0213, 0230.) These comments generally supported OSHA's proposed approach. For example, Mr. Anthony Ahern of Ohio Rural Electric Cooperatives agreed that OSHA need not duplicate the line-clearance tree-trimming requirements from § 1910.269 in subpart V (Ex. 0186). Also, Mr. James Gartland of Duke Energy commented that the requirements for line-clearance tree-trimming operations should be covered exclusively under § 1910.269, explaining that line-clearance tree-trimming operations are the same whether one considers the work to be general industry or construction (Ex. 0201).

IBEW asked OSHA to clarify whether § 1910.269 would apply even to tree-trimming operations that could be considered "construction," for example clearing around existing energized facilities for a new right of way (Ex. 0230). OSHA is applying § 1910.269 in those circumstances. Given that clarification, IBEW agreed that the § 1910.269 requirements for line-clearance tree-trimming operations do not need to be repeated in subpart V (Ex. 0230). In light of the commenters' support, OSHA is adopting § 1926.950(a)(3) as proposed with respect to line-clearance tree trimming.[46]

Although the tree trimming industry did not object to covering all line-clearance tree trimming in § 1910.269, representatives of the industry urged the Agency to expand the scope of covered line-clearance tree-trimming activities by broadening the definition of that term. (See, for example, Exs. 0174, 0200, 0502, 0503; Tr. 620–628, 765–769.) The proposed definition of "line-clearance tree trimming" in § 1926.968, which was based on existing § 1910.269(x), read as follows:

[42] Paragraph (e) of § 1910.269 contains requirements for work in enclosed spaces. OSHA recently proposed a standard covering confined spaces in construction, which will cover many of the same hazards. OSHA will consider how to apply these new confined space provisions to the construction of power generation installations in the development and promulgation of that final rule.

[43] Current § 1910.269(a)(1)(ii)(A) provides that § 1910.269 does not apply to construction work. In the final rule, OSHA is revising this paragraph to indicate that § 1910.269 does not apply to construction work, as defined in § 1910.12, except for line-clearance tree-trimming operations and work involving electric power generation installations as specified in § 1926.950(a)(3). This change makes the application of § 1910.269 consistent with the coverage of work involving electric power generation installations in subpart V.

[44] Line-clearance tree trimming is also addressed in § 1910.268 when the lines involved are telecommunications lines. (See 29 CFR 1910.268(q).)

[45] Throughout the preamble discussion of this final rule, OSHA generally refers to line-clearance tree trimmers who are not qualified employees under § 1910.269 or subpart V as "line-clearance tree trimmers," and to qualified employees who also meet the definition of "line-clearance tree trimmers" as "qualified employees."

[46] Current § 1910.269(a)(1)(ii)(A) provides that § 1910.269 does not apply to construction work. In the final rule, OSHA is revising this paragraph to indicate that § 1910.269 does not apply to construction work, as defined in § 1910.12, except for line-clearance tree-trimming operations and work involving electric power generation installations as specified in § 1926.950(a)(3). This change makes the application of § 1910.269 consistent with the coverage of line-clearance tree-trimming operations in subpart V.

The pruning, trimming, repairing, maintaining, removing, or clearing of trees or the cutting of brush that is within 3.05 m (10 feet) of electric supply lines and equipment.

The Utility Line Clearance Coalition (ULCC) commented that the definition of line-clearance tree trimming should not be limited to trees within 3.05 meters (10 feet) of an electric supply line. ULCC requested that OSHA expand the definition of "line-clearance tree trimming" to include all vegetation management work done by line-clearance tree trimmers and trainees for the construction or maintenance of electric supply lines or for electric utilities (Ex. 0502). The Tree Care Industry Association (TCIA) proposed the same change to the definition of "line-clearance tree trimming" (Ex. 0503). Both tree trimming trade associations recommended that the definition of "line-clearance tree trimming" be revised to read as follows:

The pruning, trimming, repairing, maintaining, removing, treating or clearing of trees or the cutting of brush (vegetation management) that is within 10 feet (305 cm) of electric supply lines and equipment, or vegetation management work performed by line clearance tree trimmer/trainees for the construction or maintenance of electric supply lines and/or for electric utilities. [Exs. 0502, 0503]

The industry provided three main arguments in support of its recommendation to expand the scope of tree-trimming work covered by § 1910.269. For the reasons described later, OSHA is not persuaded by the industry's arguments and will not be expanding the definition of "line-clearance tree trimming" to include all vegetation management work for the construction or maintenance of electric supply lines or for electric utilities. However, OSHA is making some changes to the definition of "line-clearance tree trimming" that will broaden, in a limited manner, the scope of tree-trimming operations covered by § 1910.269. These changes are discussed later in this section of the preamble.

The tree trimming industry's first argument in support of its recommended definition is that the "10-foot rule" (as they described it) contradicts other portions of § 1910.269. Joe Tommasi of the Davey Tree Expert Company, testifying on behalf of ULCC, noted:

[T]he minimum separation distances tables in the standard requires [*sic*] a line clearance arborist to maintain more than ten feet from some lines depending on the voltage exposures, but at the same time, the definition says that such work is not subject to [the] line clearance tree trimming standard because the standard [applies] only to trees that are within the ten feet of overhead conductors. [Tr. 622]

Mr. Tommasi also suggested that some requirements, such as those for spraying herbicides and stump cutting, may apply to work that takes place more than 3.05 meters away from power lines (Tr. 622–623).

OSHA does not find this argument persuasive. This first of the tree trimmers' arguments reflects a basic misunderstanding of the way the proposed standard worked. Under the proposed rule, tree-trimming work was covered by § 1910.269 only to the extent it was done on trees or brush within 3.05 meters of electric supply lines and equipment. If it was done on trees or brush more than 3.05 meters away from lines and equipment, none of the provisions in proposed § 1910.269 applied. The proposed "10-foot rule" did not create any internal conflicts in § 1910.269. For work done outside of the 3.05-meter boundary, the proposed provisions the industry was concerned about, that is, minimum approach distances and requirements for spraying herbicides and stump cutting, did not apply.

The tree trimmers' second justification for expanding the definition of line-clearance tree trimming in § 1910.269 is that the "10-foot rule" undermines safety by causing different safety requirements to apply to line-clearance tree trimmers depending on their distance from the line. Mr. Tommasi testified that "experience teaches that a single set of safety rules applicable to the line tree arborist achieves the highest rate of compliance and thus the highest safety" (Tr. 625). Mr. Tommasi maintained that Federal and State OSHA compliance officials have enforced other standards, such as OSHA's logging standard (29 CFR 1910.266), during arborist operations more than 3.05 meters from power lines (*id.*). Further, ULCC commented that "the foundation of worker safety in line clearance tree trimming is adherence to a single predictable set of safety standards in which employees can be trained and repeatedly drilled" (Ex. 0174).

OSHA appreciates the industry's desire for a single set of safety-related work practices, but changing the definition of "line-clearance tree trimming" in § 1910.269 would not necessarily achieve the industry's goal. As stated previously, even work covered by § 1910.269 and subpart V must comply with all other applicable general industry and construction standards. In any event, the Agency does not believe that it is necessary to employee safety to address in § 1910.269 every hazard faced by line-clearance tree trimmers. Employers in every industry, including line-clearance tree trimming firms, must identify all OSHA standards applicable to their work, along with their general duty clause obligations, and then set, communicate, and enforce a set of work rules that meets all of the applicable requirements. For example, if a line-clearance tree trimming contractor performs work that falls under the logging or site-clearing standards (§§ 1910.266 and 1926.604, respectively), the contractor will have to ensure that its work rules meet those standards, in addition to § 1910.269.[47]

The provisions on brush chippers, sprayers and related equipment, stump cutters, gasoline-engine power saws, backpack units for use in pruning and clearing, rope, and fall protection (§ 1910.269(r)(2), (r)(3), (r)(4), (r)(5), (r)(6), (r)(7), and (r)(8), respectively) in existing § 1910.269 were taken, in part, from the EEI–IBEW draft on which § 1910.269 was based. Those provisions were "checked against the equivalent ANSI standard, ANSI Z133.1–1982[, *American National Standard for Tree Care Operations—Pruning, Trimming, Repairing, Maintaining, and Removing Trees, and Cutting Brush—Safety Requirements*] ([269-]Ex. 2–29), to be sure that OSHA's regulations would better effectuate safety than the national consensus standard" (59 FR 4322). However, OSHA did not incorporate a comprehensive tree-trimming standard in § 1910.269. Thus, many important safety provisions included in applicable consensus standards and in other OSHA standards were not included in § 1910.269, and that section does not address some important safety hazards faced by workers performing tree care operations. For example, § 1910.269 does not contain any specific requirements to protect workers felling trees. Those requirements are in OSHA's logging standard. Furthermore, even with respect to the nonelectrical hazards that are regulated in the § 1910.269 tree-trimming provisions, the OSHA standards do not cover those hazards as comprehensively as the current version,

[47] ULCC suggested that the references in § 1910.269(r)(5) to specific requirements in the logging standard "shows OSHA's intent to not apply [the] logging standard to line clearance unless so-designated" (Ex. 0174). This is an erroneous interpretation that overlooks existing § 1910.269(a)(1)(iii), which explains that "[s]pecific references in this section to other sections of part 1910 are provided for emphasis only." Other relevant provisions in part 1910 continue to apply, including other provisions in the logging standard, if the work being performed falls within the scope of those standards and within the scope of § 1910.269 at the same time.

or even the 1982 version, of ANSI Z133.1.[48] For example, the new and old consensus standards include additional requirements for brush chippers and provisions on hand tools such as axes, pruners, and saws that are not contained in § 1910.269. For these reasons, adopting the industry's recommendation to have § 1910.269 be the exclusive source of requirements for tree-trimming work would not improve employee safety. Instead, it would jeopardize the workers performing those operations. For example, an employer may perform a logging operation near an overhead power line under contract with an electric utility to remove trees along the right of way for the power line. Applying the tree care industry's recommendation and logic to this work would place that work exclusively under § 1910.269, eliminating the protection provided by the logging standard's tree-felling provisions.

The Agency has published an advance notice of proposed rulemaking to gather information to use in developing a comprehensive standard on tree care operations (73 FR 54118–54123, Sept. 18, 2008). In that rulemaking, OSHA will consider whether, and to what extent, any new standard on tree care operations should cover line-clearance tree trimming.

The tree trimmers' third justification for expanding the definition of line-clearance tree trimming in § 1910.269 is that the electrical hazards regulated by § 1910.269 exist at distances greater than 3.05 meters from the line. ULCC argued that there are many circumstances that expose line-clearance tree trimmers to electrical hazards at distances beyond 3.05 meters from the line, such as when a tree or section of a tree can fall into the line even though the tree itself is farther than 3.05 meters away (Ex. 0174). To illustrate this point, Mr. Tommasi provided an example of a 15.2-meter tall oak tree located 4.6 meters from an overhead power line (Tr. 623).

OSHA has considered this argument, but has concluded that the 3.05-meter rule is generally reasonable and consistent with provisions in 29 CFR part 1910, subpart S, OSHA's general industry electrical standards. An examination of the different requirements that apply to the electrical hazards posed by tree-trimming operations will illuminate the need to set a locus within which § 1910.269 should apply.

The line-clearance tree-trimming provisions in existing § 1910.269 contain several requirements to protect line-clearance tree trimmers from electrical hazards. First, to be considered line-clearance tree trimmers under § 1910.269, employees must, through training or experience, be familiar with the special techniques and hazards involved in line-clearance tree trimming.[49] (See existing § 1910.269(a)(1)(i)(E)(2) and the definition of "line-clearance tree trimmer" in existing § 1910.269(x).) Second, there must be at least two line-clearance tree trimmers present under any of the following conditions: (1) If a line-clearance tree trimmer is to approach any conductor or electric apparatus energized at more than 750 volts more closely than 3.05 meters, (2) if branches or limbs being removed are closer than the applicable minimum approach distances to lines energized at more than 750 volts, or (3) if roping is necessary to remove branches or limbs from such conductors or apparatus. (See existing § 1910.269(r)(1)(ii).) Third, when the voltage on the lines is 50 volts or more and two or more employees are present, generally at least two employees must be trained in first aid, including cardiopulmonary resuscitation.[50] (See existing § 1910.269(b)(1).) Fourth, employees must maintain minimum approach distances appropriate for qualified employees. (See existing § 1910.269(r)(1)(iii) and (r)(1)(v).) Fifth, employees must use insulating equipment to remove branches that are contacting exposed, energized conductors or equipment or that are within the applicable minimum approach distances of energized conductors or equipment. (See existing § 1910.269(r)(1)(iv).) Sixth, line-clearance tree-trimming work may not be performed when adverse weather conditions make the work hazardous in spite of the work practices required by § 1910.269. (See existing § 1910.269(r)(1)(vi).) Seventh, mechanical equipment must maintain appropriate minimum approach distances, and certain measures must be taken to protect employees on the ground from hazards that might arise from equipment contact with energized lines. (See existing § 1910.269(p)(4).)

Requirements for tree trimmers who are not performing line-clearance tree trimming (as defined in final § 1910.269(x)), that is, "regular tree trimmers," are contained in Subpart S of the general industry standards in part 1910. It is important to note that, for the purposes of Subpart S, tree trimmers fall into two categories: (1) Regular tree trimmers, whom OSHA treats as unqualified persons, and (2) line-clearance tree trimmers (as defined in § 1910.269), whom OSHA considers qualified persons under subpart S. Line-clearance tree trimmers under § 1910.269 are exempt from the electrical safety-related work practice requirements in subpart S and must comply with the § 1910.269 requirements described previously.[51] (See § 1910.331(c)(1).) In contrast, regular tree trimmers are subject to the subpart S requirements, but are not covered by § 1910.269.[52]

Subpart S sets some basic requirements for regular tree trimmers.

[48] As stated earlier, in its review of the EEI–IBEW draft, OSHA checked provisions of that draft against equivalent provisions in ANSI Z133.1–1982. However, because § 1910.269 is a standard for electric power generation, transmission, and distribution work and not a comprehensive standard on tree trimming, the Agency did not examine provisions in the ANSI standard that had no counterpart in the EEI–IBEW draft.

[49] Throughout this preamble, OSHA differentiates between line-clearance tree trimmers (as defined in § 1910.269) and other workers involved in tree-trimming operations. OSHA refers to employees doing tree-related work who are not line-clearance tree trimmers under § 1910.269 as "regular tree trimmers" (that is, all other tree trimmers) or "tree workers who are not line-clearance tree trimmers" (that is, all other tree trimmers and ground workers). See also the summary and explanation for § 1926.950(b)(2), later in this section of the preamble.

[50] See the summary and explanation for final § 1926.951(b)(1), later in this section of the preamble, for a discussion of the requirements for first-aid training for field work, such as line-clearance tree-trimming operations.

[51] Note 2 to the definition of "line-clearance tree trimmer" in existing § 1910.269(x) explains that line-clearance tree trimmers are considered qualified employees for purposes of the electrical safety-related work practices in Subpart S (§§ 1910.331 through 1910.335). Paragraph (c)(1) of § 1910.331 provides that §§ 1910.331 through 1910.335 do not apply to work performed by qualified persons, including line-clearance tree trimmers under § 1910.269, on or directly associated with generation, transmission, and distribution installations. In addition, Note 3 to § 1910.331(c)(1) clarifies that the agency considers line-clearance tree trimming to be work directly associated with such installations.

[52] Currently, an employee must meet the definition of "line-clearance tree trimmer" in existing § 1910.269(x) and have training meeting § 1910.332(b)(3) to be considered a line-clearance tree trimmer who is a qualified employee for the purposes of subpart S. (See Note 1 to § 1910.332(b)(3), which states that a person must have the training required by that paragraph to be considered a qualified person.) As explained in the summary and explanation for §§ 1926.950(b)(2) and 1910.269(a)(2)(iii), later in this section of the preamble, OSHA added to § 1910.269 appropriate training requirements for line-clearance tree trimmers. Consequently, under this final rule, an employee must meet the definition of "line-clearance tree trimmer" and have training meeting § 1910.269(a)(2)(iii) to be considered a line-clearance tree trimmer who is a qualified employee for the purposes of subpart S. Under both the existing standards and the final rule, any given tree trimmer is either a line-clearance tree trimmer, who is considered a qualified employee under subpart S, or a regular tree trimmer, who is considered an unqualified employee under subpart S.

(Other requirements also apply, but are not germane to this discussion.) First, regular tree trimmers must be appropriately trained (see § 1910.332(b)(1) and (b)(2)), although the training required for regular tree trimmers is not as extensive as that required for line-clearance tree trimmers. Second, regular tree trimmers must generally maintain a minimum separation of 3.05 meters from overhead power lines (see § 1910.333(c)(3)(i) and (c)(3)(iii)). Finally, regular tree trimmers working on the ground may not contact vehicles or mechanical equipment capable of having parts of its structure elevated near energized overhead lines, except under certain conditions (see § 1910.333(c)(3)(iii)(B)).

As a general matter, OSHA believes that workers performing line-clearance tree-trimming operations under existing § 1910.269 are afforded more protection than workers performing regular tree-trimming operations under Subpart S. Under existing § 1910.269, line-clearance tree-trimming operations generally require the presence of at least two line-clearance tree trimmers trained in first aid, including cardiopulmonary resuscitation. Subpart S does not have a comparable requirement. Existing § 1910.269 forbids line-clearance tree-trimming operations from being performed when adverse weather conditions make work unsafe. Subpart S does not address weather conditions. Furthermore, in comparison with subpart S, existing § 1910.269 contains additional requirements to protect workers in case mechanical equipment contacts a power line. OSHA believes that these important protections in existing § 1910.269 must be required only when tree-trimming operations expose employees to the most serious electrical hazards, not any time electrical hazards are present, as posited by ULCC.

OSHA believes that the seriousness of electrical hazards posed by tree trimming depends on how close the tree is to the power line. The closer the tree is to the power line, the more difficulty the worker has in maintaining minimum approach distances. For example, roping may be necessary to maintain the required minimum approach distances. (This practice is addressed in existing § 1910.269(r)(1)(ii)(C).) Furthermore, when the tree is close to the power line, a worker trimming trees from an aerial lift has to be more concerned with the distances between the power line and the tree, the aerial lift, and himself or herself. The farther the tree is from the power line, the more room an employee has in which to maneuver the aerial lift.

Therefore, the Agency has only to decide how close the tree needs to be to a power line before the protections required by § 1910.269 are necessary. The Agency concludes that those protections should start when the tree is 3.05 meters from a power line. Under Subpart S, unqualified employees are not permitted within that distance, but they are permitted to work in compliance with subpart S outside of that distance (plus 100 millimeters (4 inches) of additional distance for every 10 kilovolts over 50 kilovolts). (See § 1910.333(c)(3)(i).) OSHA believes that it would be inconsistent to expand the definition of "line-clearance tree trimming" to the point that line-clearance tree trimmers working on trees or brush more than 3.05 meters from the lines would be entitled to the enhanced protections of § 1910.269, while employees doing other types of work closer to the lines (between 3.05 meters from the line and where the line-clearance tree trimmers are working) would be governed by the more limited protections afforded by subpart S. The Agency generally believes that any electrical hazards that are present when a tree is more than 3.05 meters from power lines are addressed adequately by subpart S.

Nevertheless, changes to the existing definition of "line-clearance tree trimming" in § 1910.269 (which is identical to the definition proposed for subpart V) are necessary to ensure consistency with the 3.05-meter rule that applies to unqualified employees under § 1910.331(c)(3)(i). As noted previously, under § 1910.333(c)(3)(i)(A)(*1*), 3.05 meters is the minimum distance an unqualified employee must maintain from overhead power lines. If the voltage is higher than 50 kilovolts, the required distance under § 1910.333(c)(3)(i)(A)(*2*) increases by 100 millimeters for every 10 kilovolts of voltage above 50 kilovolts. OSHA believes that this increase in distance reasonably captures the relationship between the severity of the electrical hazard and voltage. Therefore, OSHA decided that, although it is not expanding the definition of "line-clearance tree trimming" to the extent recommended by the tree trimming industry, it will add this extra distance to the definition of "line-clearance tree trimming" to accord with § 1910.333(c)(3)(i)(A). The revised definition appears in §§ 1910.269(x) and 1926.968.

Paragraph (b) of final § 1926.950 addresses training for employees. Subpart V currently contains no general provisions related to training employees in the safety practices necessary to perform electric power transmission and distribution work. It is widely recognized that the types of work covered by this standard require special knowledge and skills. Additionally, final subpart V contains many safety-related work practice requirements that are necessary for the protection of employees. To gain the requisite knowledge and skills to use these work practices, employees must be adequately trained. Therefore, in the proposed revision of subpart V, OSHA included training requirements mirroring those already in § 1910.269, with a few changes and additions (discussed later). OSHA notes that editorial changes are being made throughout paragraph (b) to clarify that employers must ensure that "each" employee covered by a specific training provision receives the training required by that provision.[53]

Paragraph (b)(1) contains training requirements applying to all employees performing work covered by subpart V. Siemens Power Generation and ORC Worldwide suggested deleting the heading "All employees" from proposed paragraph (b)(1). They expressed concern that the provision could be construed to require training for clerical employees or other workers doing tasks not covered by subpart V (Exs. 0163, 0208, 0235). Siemens commented:

> By adding the word "ALL" the Agency is implying that training must be conducted for any and all employees regardless of their scope of task. It implies for example, that even for clerical employees that have no risk, there must be some documented training conducted to comply with this requirement. [Ex. 0163]

OSHA appreciates these concerns, but has elected to retain the title in paragraph (b)(1) as proposed. The Agency thinks that it is important to distinguish the training requirements in

[53] Several provisions in the proposed rule and existing § 1910.269 require employers to provide personal protective equipment (PPE) and training for "employees" or for "all employees." The final rule amends these provisions to require PPE and training for "each employee." These editorial, nonsubstantive changes emphasize that the standards' training and PPE requirements impose a compliance duty to each and every employee covered by the standards and that noncompliance may expose the employer to liability on a per-employee basis. This action is in accord both with OSHA's longstanding position and OSHA standards addressing employers' duties. (See §§ 1910.9 and 1926.20(f); see also 73 FR 75568 (Dec. 12, 2008)). It should be noted that, if any provision in the final rule continues to require training or PPE for "employees" or for "all employees," rather than for "each employee," as described above, this was an unintentional omission on OSHA's part and should not be interpreted as amending OSHA's longstanding position, or the general standards, addressing employers' duties to provide training and PPE to each employee.

paragraph (b)(1), which is broadly applicable to workers doing work covered by subpart V, from the requirements in paragraph (b)(2), which is applicable only to "qualified employees." OSHA clarified in the proposal, and is reiterating here, that paragraph (b)(1) does not impose training requirements on employees who are not performing work covered by subpart V. The text of paragraph (b)(1) is self-limiting—employers need only ensure that each employee receives safety training that "pertain[s] to his or her job assignments" and that is "related to his or her work."

As clerical workers do not perform the types of hazardous work covered by subpart V, this provision does not require employers to train such employees in live-line barehand or other work techniques addressed by this final rule. Employees performing clerical work or other work not covered by subpart V would not need to receive the same electrical safety training required for workers involved in the construction of transmission and distribution lines and equipment. However, employers must train clerical workers performing work covered by subpart V in the hazards to which they might be exposed.

Proposed paragraphs (b)(1)(i) and (b)(1)(ii) were borrowed in large part from provisions in existing § 1910.269. Paragraph (b)(1)(i) requires each employee to be trained in, and be familiar with, the safety-related work practices, safety procedures, and other safety requirements in subpart V that pertain to his or her job assignments. OSHA considers this training necessary to ensure that employees use the safety-related work practices outlined in subpart V. It should be noted that this provision requires employers to train employees not only in the content of the applicable requirements of the final rule but in how to comply with those requirements. OSHA received no comments on proposed paragraph (b)(1)(i) and is carrying it forward into the final rule without substantive change.

Proposed paragraph (b)(1)(ii) additionally provided that employees had to be trained in, and be familiar with, any other safety practices related to their work and necessary for their safety, including applicable emergency procedures, such as pole-top and manhole rescue. Proposed paragraph (b)(1)(ii) required that safety training be provided in areas that are not directly addressed by subpart V, but that are related to the employee's job. This training fills in the gaps left when the final rule does not specify requirements for every hazard the employee may encounter in performing electric power generation, transmission, or distribution work. OSHA explained in the preamble to the proposal that if more than one set of work practices could be used to accomplish a task safely, the employee would only need to be trained in the work methods to be used (70 FR 34833). For example, an insulator on a power line could be replaced by an employee using live-line tools or rubber insulating equipment or by an employee working without electrical protective equipment after deenergizing and grounding the line. The employee would only need to be trained in the method actually used to replace that insulator.

The Agency received numerous comments suggesting that the training requirement proposed in paragraph (b)(1)(ii) was too broad (Exs. 0156, 0160, 0168, 0170, 0202, 0206, 0207, 0229, 0233, 0237). Mr. Don Adkins of Davis H. Elliot Company, an electrical contractor, commented, for example, that this proposed provision was "impermissibly broad" and offered "no guidance as to what safety practices are 'related' to the work of those covered by the standard" (Ex. 0156). Mr. Robert Matuga of the National Association of Home Builders (NAHB) believed that paragraph (b)(1)(ii) was "overly broad," potentially "creating an obligation for employers to provide training to workers . . . on almost every hazard that could conceivably be encountered on a construction jobsite" (Ex. 0168). He also argued that proposed paragraph (b)(1)(ii) is duplicative of § 1926.21(b)(2), which requires "[t]he employer [to] instruct each employee in the recognition and avoidance of unsafe conditions and the regulations applicable to his work environment to control or eliminate any hazards or other exposure to illness or injury" (*id.*). Also, the U.S. Small Business Administration's (SBA) Office of Advocacy commented:

> The scope of this mandatory employee training is not limited to work practices required by the proposed electrical standards, but extends to any other safety practices that are related to their work and necessary for their safety. The SBREFA panel was concerned that this language was overly broad and could be viewed as covering other, non-specified hazards on the worksite, such as ergonomic injuries from overhead work.
> * * * * *
> The proposed training language remains vague and OSHA should clarify what training is necessary to comply with the standard (as well as what alternative training is acceptable for compliance) [Ex. 0207]

Despite these comments, OSHA continues to believe that the requirement in proposed paragraph (b)(1)(ii) is essential to the safety and welfare of employees and is adopting it without significant change in this final rule. Mr. Brian Erga of Electrical Safety Consultants International (ESCI) supported the proposed training requirements and attributed an increase in employee proficiency, and safer work environments, to the adoption of these provisions in existing § 1910.269. He explained:

> It has been shown time and time again that high quality training and retraining not only provides a safer work site, but returns dividends in financial contributions and long term productivity to the employer. The proposed [1926.]950(b) and associated verbiage in the preamble, if followed, will, in our opinion, move the industry to a safer work site. The current training requirements in 1910.269 and [the] proposed training requirements are not unduly burdensome, and will provide a more educated and experienced work force. [Ex. 0155]

Further, Mr. Donald Hartley with IBEW testified at the 2006 public hearing that "ensur[ing] that . . . employees are trained in the safety-related work practices, procedures, and requirements that pertain to their . . . assignments . . . is necessary to ensure that employees are equipped to deal with potential hazards associated with this dangerous work" (Tr. 876). He did not suggest that this training be limited only to the safety practices and other safety requirements in subpart V. Several rulemaking participants recognized that subpart V does not specifically address all hazards faced by employees performing covered work and suggested that training is an important factor in employee safety. For example, Mr. Lee Marchessault testified about the importance of training in substation rescue procedures, stating, "You should do rescue training from substation structures" (Tr. 572). Also, Energy United EMC commented that "proper training is necessary" to prevent employees in insulated aerial lifts from touching conductors (Ex. 0219). The record also indicates that employers train employees to protect them from heat-stress hazards (see, for example, Tr. 1129–1130), to ensure proper maintenance of protective clothing (see, for example, Tr. 471), and to supplement the line-clearance tree-trimming requirements in existing § 1910.269 (see, for example, Tr. 683).

Existing § 1910.269(a)(2)(i) already contains a requirement identical to the one proposed in § 1926.950(b)(1)(ii), and OSHA has successful enforcement experience with this provision. First, except for two questions addressing who needs to be trained in emergency and rescue procedures, the Agency has

not received any letters requesting interpretation or clarification of this provision, leading the Agency to believe that the requirement is not as ambiguous as the commenters claim. Second, OSHA has issued only a few citations under existing § 1910.269(a)(2)(i) (for example, in 2008, OSHA issued only 2 citations of § 1910.269(a)(2)(i) in 362 inspections of electric utilities), which supports OSHA's conclusion that employees performing work under existing § 1910.269 are generally being trained as required. Third, even EEI admits that "EEI members have generally found the training requirements of paragraph 1910.269(a)(2) to be workable for their employees" (Ex. 0227). Thus, it appears that electric utilities have not had difficulty complying with the identical requirement in existing § 1910.269(a)(2)(i).

On the other hand, the Agency agrees with these commenters that § 1926.950(b)(1)(ii) of the final rule sets a broad, general requirement to train employees. This is not an uncommon approach for an OSHA standard to take. OSHA's personal protective equipment (PPE) standards in §§ 1910.132(a) and 1926.95(a) require the employer to provide and ensure the use of protective equipment wherever it is necessary by reason of hazards of processes or environment, chemical hazards, radiological hazards, or mechanical irritants encountered in a manner capable of causing injury or impairment in the function of any part of the body through absorption, inhalation or physical contact. An employer is deemed to be in violation of the PPE standards when it fails to provide PPE despite having actual or constructive knowledge of a hazard in its facility for which protective equipment is necessary. (See, for example, *Cape & Vineyard Div. of the New Bedford Gas & Edison Light Co. v. OSHRC,* 512 F.2d 1148, 1152 (1st Cir.1975).) The general construction training requirement contained in § 1926.21(b)(2) is similarly broad, requiring employers to instruct each employee in the recognition and avoidance of unsafe conditions and the regulations applicable to his or her work environment to control or eliminate any hazards or other exposure to illness or injury. That standard has been interpreted to require employers to provide employees with "the instructions that a reasonably prudent employer would have given in the same circumstances." (*El Paso Crane & Rigging Co., Inc.,* 16 BNA OSHC 1419 (No. 90–1106, Sept. 30, 1993); see also *Pressure Concrete Constr. Co.,* 15 BNA OSHC 2011 (No. 90–2668, Dec. 7, 1992) ("Because section 1926.21(b)(2) does not specify exactly what instruction the employees must be given, the Commission and the courts have held that an employer must instruct its employees in the recognition and avoidance of those hazards of which a reasonably prudent employer would have been aware.").) The applicability of § 1926.21(b)(2) turns on an employer's actual or constructive knowledge of hazards, just as under the general PPE requirements. (See, for example, *W.G. Fairfield Co.* v. *OSHRC,* 285 F. 3d 499 (6th Cir. 2002).)

OSHA is applying final paragraph (b)(1)(ii) in the same manner. Therefore, if an employer has actual knowledge of a hazard (for example, through safety warnings from equipment manufacturers or through injury experience), or if the employer has constructive knowledge of a hazard (for example, when industry practice recognizes particular hazards), then each employee exposed to the hazard must be trained. For the training to comply with this provision, it must be sufficient to enable the employee to recognize the hazard and take reasonable measures to avoid or adequately control it.

In addition, OSHA agrees with Mr. Matuga that, except to the extent that it only covers Subpart V work, paragraph (b)(1)(ii) requires the same training as § 1926.21(b)(2). Consequently, employers who meet § 1926.21(b)(2) also meet final § 1926.950(b)(1)(ii). Even though the final rule duplicates the general construction training provision, the Agency is adopting paragraph (b)(1)(ii) to maintain consistency with existing § 1910.269.

Mr. Lee Marchessault with Workplace Safety Solutions recommended that paragraph (b)(1)(ii) refer to rescues at heights generally, rather than just pole-top rescue, in the parenthetical listing examples of potentially applicable emergency procedures (Tr. 572). He noted that rescue procedures are performed from wind turbines, towers, and substation structures, as well as utility poles (*id.*).

OSHA has decided not to adopt this recommendation because no change is necessary. The types of emergency procedures listed in paragraph (b)(1)(ii) in the final rule are examples only. Pole-top rescue is listed because it is a widely recognized and used emergency procedure. The Agency notes, however, that training in these other types of emergency procedures is required if it is necessary for employee safety during the work in question.

OSHA proposed to add a new provision to both subpart V and § 1910.269 clarifying that the degree of training required is based on the risk to the employee for the task involved. OSHA explained that, under this proposed paragraph, the training provided to an employee would need to be commensurate with the risk he or she faces (70 FR 34834). The two provisions, proposed §§ 1910.269(a)(2)(i)(C) and 1926.950(b)(1)(iii), were based on § 1910.332(c), although § 1910.332(c) does not contain the "for the task involved" language. The purpose of these new training paragraphs was to ensure that an appropriate level of training is provided to employees. Employees who face little risk in their job tasks need less training than those whose jobs expose them to more danger. OSHA believed that this provision would ensure that employers direct their training resources where they will provide the greatest benefit, while still making sure that all employees receive adequate training to protect them against the hazards they face in their jobs (*id.*). OSHA noted in the preamble to the proposal that training already provided in compliance with existing § 1910.269 would be considered sufficient for compliance with these paragraphs (*id.*). The provisions would not require employers to make changes to existing training programs that comply with § 1910.269; rather, they would provide employers with options to tailor their training programs and resources to employees with particularly high-risk jobs (*id.*).

OSHA received several comments regarding paragraph (b)(1)(iii) of proposed § 1926.950. (See, for example, Exs. 0128, 0162, 0163, 0169, 0177, 0201, 0209, 0210, 0212, 0221, 0225, 0227, 0235; Tr. 873–874, 1316–1319, 1332–1333.)[54] Some commenters maintained that this provision was unnecessary or too vague. For example, Mr. Pat McAlister of Henry County REMC requested additional guidance to "clarify generally when and how risks link with training and [how to assign] the appropriate level of training to offset those risks" (Ex. 0210). EEI commented that this proposed training provision was unnecessary, explaining:

> We question the soundness of changing the [current] requirements [in § 1910.269] because if compliance with existing Section 1910.269 training requirements is sufficient, there is no reason to add another regulatory

[54] The remaining discussion of these provisions refers to the proposed construction requirement. However, the comments and OSHA's resolution of those comments applies equally to the corresponding general industry provision as is generally the case throughout this preamble.

requirement, and the proposed provisions demonstrably have no purpose. The stated explanation is that the standard is intended to "provide employers with options," but employers have those options without the added regulation. No additional provisions are necessary to preserve existing options. [Ex. 0227]

EEI went on to suggest that the added requirement would create confusion, commenting:

EEI's concern is that the new language will likely create confusion among many employers who do not have access to or regularly consult the preambles to OSHA standards. All but the most sophisticated readers likely will assume that the revised standard imposes a requirement to modify existing training programs. Moreover, the proposal is unclear: The meaning of the term "degree of training" is difficult to discern in that it is not evident how OSHA would classify and evaluate a "degree" of training. [*Id.*]

Many of the comments received on proposed paragraph (b)(1)(iii) expressed concern only about the language tying training to "the task involved." For example, Mr. Mark Spence with Dow Industries generally supported the proposed provision, but stated that the similar requirement in § 1910.332(c), which does not contain the "for the task involved" language, "has been in effect since 1990 without causing significant problems for employers" (Ex. 0128). Mr. Spence had concerns about the additional language in proposed paragraph (b)(1)(iii), explaining:

[T]he proposal refers to training "for the task involved". Training programs typically are broad, rather than task-specific. [T]he present wording could be interpreted to indicate an unmanageable requirement to train affected employees on the details of each individual task. OSHA should consider re-wording this provision or clarifying that it means that, where necessary, additional training may be required for a particular task . . . [*Id.*]

Mr. Tom Chappell of Southern Company similarly noted that "[d]ue to the large number of different tasks that an employee may need to perform, it would be difficult to evaluate each task and identify the level of training that would be required" (Ex. 0212). Consumers Energy commented that, in its experience, "employees can safely complete hundreds of specific tasks" without the need for training in each task individually (Ex. 0177). Mr. Donald Hartley of IBEW testified that the requirement "to tie the degree of training to the risk to the employee for the task involved . . . is both an unworkable and inappropriate standard" (Tr. 873–874). Mr. William Mattiford with Henkels & McCoy testified:

[I]t's not very clear as to what by definition, the degree of training shall be determined by the risk to the employee for the task involved. And that's where we see it's very confusing.

And if it's literally taken that way, then it's each individual task. So it's not just setting a pole, but it's digging a hole, to set the pole, to prefab the pole. Each one of those things could be, I guess, understood as being training for each one of those tasks.

And I feel as though, many of us feel as though that by the design of the training programs today that have redundancy and overlapping in them, you do cover all of those.

But to actually spell out perhaps a lesson plan for each one of those tasks I think would be just too difficult to do, if not impossible. [Tr. 1339]

Mr. Wilson Yancey with Quanta Services agreed with these comments:

I agree with Bill's comments, too. I think most of that is being covered today. If we have to go down and copy it and put lesson plans for everything, we will never get it accomplished and it will be too costly to the contractor. [Tr. 1340]

OSHA continues to believe that it is important that the level of training provided to employees be commensurate with the risk they encounter. Focusing training where the risk is greatest maximizes the benefits to be achieved. In addition, providing no more training than is necessary for hazards that pose less risk can conserve valuable, and often limited, safety and health resources. OSHA successfully used this general approach in § 1910.332(c), allowing employers flexibility in providing training to employees, yet ensuring that employees most at risk receive the most training. This approach is recognized by the Agency's publication "Training Requirements in OSHA Standards and Training Guidelines." [55]

On the other hand, the Agency understands the rulemaking participants' concerns. Most commenters objected to providing a level of training determined by "the task involved." Although employees are trained to perform the various tasks involved in their jobs, as noted by Mr. Mattiford (Tr. 1339), examining each task to determine the relative risk may seem daunting and unworkable as claimed by Mr. Hartley (Tr. 873–874). Employers should, however, be capable of determining the relative risk of the various hazards encountered by their employees. To clarify this requirement, OSHA replaced the phrase "for the task involved" from the proposal with the phrase "for the hazard involved" in paragraph (b)(1)(iii) of the final rule.

To determine the relative risk encountered by employees, employers are encouraged to follow the guidelines in OSHA's publication "Training Requirements in OSHA Standards and Training Guidelines," Voluntary Training Guidelines, Section III. In any event, employers may allocate training resources in accordance with their own determination of relative risk, provided that each affected employee receives the minimum training required under subpart V.

Paragraph (b)(2) contains additional requirements for training qualified employees. Because qualified employees may work extremely close to electric power lines and equipment and, therefore, encounter a high risk of electrocution, it is important that they be specially trained. Towards this end, the standard requires that these employees be trained in: distinguishing exposed live parts from other parts of electric equipment; determining nominal voltages of exposed live parts; applicable minimum approach distances and how to maintain them; the techniques, protective equipment, insulating and shielding materials, and tools for working on or near exposed live parts; and the knowledge necessary to recognize electrical hazards and the techniques to control or avoid these hazards. The language in paragraph (b)(2) generally mirrors language in existing § 1910.269(a)(2)(ii). However, paragraph (b)(2)(v), which requires training in how to recognize and control or avoid electrical hazards, has no counterpart in existing § 1910.269. In addition, OSHA has added language to paragraph (b)(2)(iii) of the final rule explicitly requiring employers to train qualified employees in the skills and techniques necessary to maintain minimum approach distances. See the summary and explanation of final § 1926.960(c)(1), later in this section of the preamble, for an explanation of this change.

NIOSH commented that qualified and unqualified employees are exposed to the same electrical hazards and should receive the same training (Ex. 0130). NIOSH suggested that "[a]ll workers potentially exposed to electrocution hazards should be trained in hazard awareness and the identification and control of these hazards, as qualified employees are trained" (*id.*). NIOSH specifically noted that line-clearance tree trimmers and ground workers face

[55] This document can be obtained by contacting OSHA's Office of Publications as directed in the **ADDRESSES** section of this preamble or from OSHA's Web page: *http://www.osha.gov/pls/publications/publication.html.* See, in particular, Section III of the voluntary guidelines, "Matching Training to Employees," on pp. 6–8.

electrical hazards comparable to those of qualified employees (*id.*).

OSHA does not believe that is appropriate to adopt requirements in this final rule for the training of ground workers on tree crews or other tree workers who are neither qualified employees under § 1910.269 nor line-clearance tree trimmers. Subpart S, not § 1910.269 or subpart V, applies to electrical safety-related work practices of ground workers on tree crews and other tree workers who are not line-clearance tree trimmers. (See § 1910.331(b).) The preamble to the 1994 § 1910.269 final rule makes this clear as follows:

> Other tree workers do not have the training necessary for them to be either "qualified employees" or "line-clearance tree trimmers", as defined under § 1910.269(x). These employees are not covered under § 1910.269 at all. The work practices these employees must use are contained in Subpart S of Part 1910. Under Subpart S, tree workers must maintain a 10-foot minimum approach distance from overhead lines. (In fact, trimming any branch that is within 10 feet of an overhead power line is prohibited by Subpart S.) [59 FR 4410; footnotes omitted.]

Existing § 1910.269(a)(1)(ii)(B) states that § 1910.269 does not cover "electrical safety-related work practices . . . covered by subpart S." Consequently, addressing the training of ground workers on tree crews or other tree workers who are neither qualified employees nor line-clearance tree trimmers in § 1910.269 or subpart V would be inappropriate.

On the other hand, OSHA believes that the final rule should address the training of line-clearance tree trimmers. However, not all of the training requirements in final § 1910.269(a)(2)(ii), which are applicable to qualified employees, are appropriate for line-clearance tree trimmers. Qualified employees are trained to work on energized parts. Specifically, the final rule requires qualified employees to be trained in, among other topics, 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 (§ 1926.950(b)(2)(iv)). This training enables qualified employees to work directly on energized parts of electric circuits, which line-clearance tree trimmers do not do.

Line-clearance tree trimmers work close to, but not on, energized, overhead power lines. (See, for example, Ex. 0502; Tr. 611.) Consequently, the Agency believes that these employees have different training needs than qualified employees covered by § 1910.269. Under existing § 1910.269, OSHA has addressed the training for line-clearance tree trimmers in the definition of "line-clearance tree trimmer" and in the notes to that definition. The definition and notes appear in existing § 1910.269(x). Note 2 to that definition explains that while line clearance tree trimmers are not considered qualified employees for purposes of § 1910.269, they are considered to be qualified employees exempt from the electrical safety-related work practice requirements in subpart S (§§ 1910.331 through 1910.335). The note following § 1910.332(b)(3) indicates that, for the purposes of §§ 1910.331 through 1910.335, a person must have the training required by § 1910.332(b)(3) for OSHA to consider that person a qualified person. Therefore, to be considered a line-clearance tree trimmer under § 1910.269 and, thus, a qualified person under subpart S, a tree trimmer needs the training specified by § 1910.332(b)(3). Any tree trimmer who has not had such training is considered an unqualified person under subpart S, and the electrical safety-related work practices in that standard apply instead of those in § 1910.269 as explained previously.

The training required by § 1910.332(b)(3) is virtually identical to the training required by final § 1910.269(a)(2)(ii)(A) through (a)(2)(ii)(C) for qualified employees, except that § 1910.332(b)(3)(iii) requires training in the clearance (that is, minimum approach) distances specified in § 1910.333(c), whereas § 1910.269(a)(2)(ii)(C) requires training in the minimum approach distances in § 1910.269 and in the skills and techniques necessary to maintain those distances. Considering NIOSH's recommendation, OSHA believes that putting appropriate training requirements for line-clearance tree trimmers directly in § 1910.269 rather than applying them indirectly through definitions and scope statements will make the standards more transparent and make the obligation to train these workers clearer. Consequently, the Agency is adopting a new § 1910.269(a)(2)(iii) requiring line-clearance tree trimmers to be trained in: (1) The skills and techniques necessary to distinguish exposed live parts from other parts of electric equipment (final § 1910.269(a)(2)(iii)(A)), (2) the skills and techniques necessary to determine the nominal voltage of exposed live parts (final § 1910.269(a)(2)(iii)(B)), and (3) the minimum approach distances in the final rule corresponding to the voltages to which the line-clearance tree trimmer will be exposed and the skills and techniques necessary to maintain those distances (final § 1910.269(a)(2)(iii)(C)).[56] The first two training requirements, final § 1910.269(a)(2)(iii)(A) and (a)(2)(iii)(B), are identical to § 1910.332(b)(3)(i) and (b)(3)(ii). The remaining requirement, final § 1910.269(a)(2)(iii)(C), is comparable to § 1910.332(b)(3)(iii), except that line-clearance tree trimmers need to be trained in the minimum approach distances required under § 1910.269 rather than those in subpart S and need to be trained in the skills and techniques necessary to maintain those distances. OSHA concludes that the minimum approach distances required under § 1910.269 are the more appropriate reference for final § 1910.269(a)(2)(iii)(C) because line-clearance tree trimmers are required to comply with the minimum approach distances in § 1910.269.[57] The Agency also concludes that line-clearance tree trimmers need to be trained in the skills and techniques necessary to maintain the required minimum approach distances for the same reasons that qualified employees must be trained in these subjects. (See the discussion of minimum approach distances under the summary and explanation for final § 1926.960(c)(1), later in this section of the preamble.) OSHA believes that training in these skills and techniques are even more important for line-clearance tree trimmers, who, unlike qualified employees, generally work without electrical protective equipment (see, for example, Ex. 0503).

Paragraph (b)(2)(v), which is being adopted without change from the proposal, requires qualified employees to be trained in the recognition of electrical hazards to which the employee may be exposed and the skills and techniques necessary to control or avoid those hazards. Commenting on proposed § 1910.269(a)(2)(ii)(E), which is the general industry counterpart to proposed § 1926.950(b)(2)(v), Mr. Kevin Taylor of Lyondell Chemical Company requested clarification of the training required for workers who operate, but do not maintain, 480-volt circuit breakers (Ex. 0218). Workers operating these circuit breakers need not be

[56] Line-clearance tree trimming firms may need to train their employees in the more protective of the minimum approach distances in subpart S and § 1910.269 to ensure compliance both during work that is covered by subpart S and work that is covered by § 1910.269.

[57] Even though line-clearance tree trimmers are not generally qualified employees under § 1910.269, paragraph (r)(1)(iii) of final § 1910.269 requires them to maintain the minimum approach distances specified in Table R–5, Table R–6, Table R–7, and Table R–8.

qualified employees unless the devices are in areas restricted to qualified employees (final §§ 1910.269(u)(4) and (v)(4) and 1926.966(e)) or otherwise expose the employees to contact with live parts (final § 1910.269(l)(1) and 1926.960(b)(1)). Thus, assuming that these workers are not qualified employees, they would need to be trained only as required by final §§ 1910.269(a)(2)(i) and 1926.950(b)(1). The scope of this training is described earlier in this section of the preamble under the discussion of final § 1926.950(b)(1).

OSHA proposed to supplement the training requirements in paragraphs (b)(1) and (b)(2) with requirements for supervision and additional training in paragraphs (b)(3) and (b)(4). These requirements were taken directly from existing § 1910.269(a)(2)(iii) and (a)(2)(iv). The Agency explained in the proposal that initial instruction in safe techniques is not sufficient to ensure that employees will use safe work practices all of the time (70 FR 34834). Continual reinforcement of this initial training must be provided to ensure that the worker uses the procedures he or she has been taught. This reinforcement can take the form of supervision, safety meetings, prejob briefings or conferences, and retraining.

Paragraph (b)(3), which is being adopted without change from the proposal, requires the employer to determine, through regular supervision (that is, supervision that takes place on a periodic basis throughout the year) and inspections conducted at least annually, that each employees is complying with the safety-related work practices required by subpart V. Paragraph (b)(4), also being adopted without change from the proposal, requires additional training (or retraining) whenever:

- Regular supervision or an annual inspection required by paragraph (b)(3) indicates that the employee is not following the safety-related work practices required by subpart V,
- New technology, new types of equipment, or changes in procedures necessitate the use of safety-related work practices that are different from practices that the employee would normally use, or
- The employee must use safety-related work practices that are not normally used during his or her regular job duties.

A note to paragraph (b)(4)(iii) explains that retraining must be provided before an employee performs a task that is done less frequently than once a year. Instruction provided in prejob briefings is acceptable if it is detailed enough to fully inform the employee of the procedures involved in the job and to ensure that he or she can accomplish them in a safe manner.

Mr. Leo Muckerheide of Safety Consulting Services commented that the requirements for retraining in proposed paragraph (b)(4) were reactive rather than proactive (Ex. 0180). He recommended that the standard require 4 to 8 hours of retraining every 2 to 3 years, arguing that workers follow proper safety practices immediately after training, but drift away from those practices as time goes on.

OSHA does not agree that the retraining requirements in paragraph (b) are exclusively reactive. Employees performing work covered by the final rule typically employ the safety-related work practices required by the standard on a daily or other regular basis. The Agency believes that workers generally will continue to follow these practices over time and has no evidence that a lack of regularly scheduled retraining contributes to a failure to follow safe work practices that are used frequently. OSHA does recognize, however, that retraining is important for work practices that are employed infrequently. Thus, paragraphs (b)(4)(ii) and (b)(4)(iii) require employees to receive additional training if they need to use new or different safety-related work practices or safety-related work practices that are not part of their regular job duties. For example, under paragraph (b)(4)(iii), an employee who is expected to administer CPR in the event of an emergency needs retraining if he or she has not used those emergency practices over the course of the previous year. Retraining would also be required for an employee who needs to climb a pole if it has been more than a year since he or she has used pole-climbing practices.[58] OSHA does not believe that any changes to paragraph (b)(4) are necessary and is adopting that paragraph without change from the proposal.

Under paragraph (b)(5), training required by paragraph (b) can be provided in a classroom or on-the-job, or in both places. This paragraph is taken directly from existing § 1910.269(a)(2)(v). The Agency has found these types of instruction, which provide workers an opportunity to ask questions and have the employer respond to them, to be most effective. (See, for example, OSHA's publication "Training Requirements in OSHA Standards and Training Guidelines.") OSHA received no comments on this provision, and it is being adopted as proposed.

Paragraph (b)(6) provides that training given in accordance with § 1926.950(b) has to result in employee proficiency in required work practices and introduce procedures necessary for subpart V compliance. OSHA did not receive any comments on this paragraph, which is borrowed from existing § 1910.269(a)(2)(vi), and is adopting it without change from the proposal. Unless a training program establishes an employee's proficiency in safe work practices and that employee then demonstrates his or her ability to perform the necessary work practices, there will be no assurance that the employee will work safely. An employee who has attended a single training class on a complex procedure, for example lockout and tagging procedures used in an electric generating plant, will not generally be deemed proficient in that procedure. Paragraph (b)(6), and the demonstration of proficiency requirement contained in paragraph (b)(7) (discussed later), will ensure that employers do not try to comply with § 1926.950(b) by simply distributing training manuals to employees. These provisions require employers to take steps to assure that employees comprehend what they have been taught and that they are capable of performing the work practices mandated by the standard. OSHA believes that this maximizes the benefits of the training required under the final rule.

Existing § 1910.269(a)(2)(vii) requires employers to certify that each employee has received required training. The certification has to be made when the employee demonstrates proficiency in the relevant work practices and maintained for the duration of the employee's employment. OSHA proposed to eliminate this certification requirement and to replace it with paragraphs in both § 1910.269 (paragraph (a)(2)(vii)) and subpart V (§ 1926.950(b)(7)) that simply require the employer to determine that each employee has demonstrated proficiency in the necessary work practices. In proposing this change, the Agency aimed to reduce unnecessary paperwork burdens on employers (70 FR 34835). In the preamble to the proposal, OSHA explained that, in the absence of training certifications, compliance with training requirements could be determined through employee interviews (*id.*). A note following this proposed paragraph explained that, although not required, employee

[58] OSHA interprets the phrase "must employ" in paragraph (b)(4)(iii) to include both practices the employer specifically assigns to the employee and practices the employer expects the employee to be prepared to use, such as emergency response procedures.

training records could continue to be used by employers to track when employees demonstrate proficiency. OSHA specifically requested comments on whether the existing certification requirement is necessary and whether the proposed standard, without a certification requirement, was adequately protective.

OSHA received a lot of feedback on this issue. Many rulemaking participants supported OSHA's proposal. (See, for example, Exs. 0125, 0127, 0159, 0169, 0171, 0175, 0177, 0179, 0186, 0212, 0222, 0227.) For instance, Mr. Brian Skeahan of Public Utility District No. 1 of Cowlitz County commented that the change from the certification requirement to the requirement to demonstrate proficiency was an "acceptable modification," pointing out that recording on-the-job training can be burdensome (Ex. 0159). Mr. Wilson Yancey of Quanta Services provided similar comments, expressing "support [for] OSHA's proposal to require only that the employer ensure that the employee is able to demonstrate proficiency" (Ex. 0169). He commented that the "certification requirement is an unnecessary recordkeeping burden that would be difficult to administer in practice because of the way that crews are spread out and would not advance employee safety and health in any material way" (*id.*). Mr. Brooke Stauffer of the National Electrical Contractors Association also supported the proposal: "NECA supports the proposed changes from certification of training to demonstration of proficiency. We do not support a requirement to keep records of employee training, due to high turnover in the line construction industry. Such record-keeping also isn't feasible to document on-the-job training . . . ." (Ex. 0171). EEI commented that "in the experience of EEI members, the existing training certification requirement in paragraph 1910.269(a)(2)(vii) has proven to be of no value, and is unnecessary and should be eliminated" (Ex. 0227). Also, Southern Company told OSHA:

> Since on-the-job training is recognized as a method for training employees, it would be difficult or impossible to maintain records for this type of training. We agree that records of training that are normally maintained (classroom instruction or hands-on training exercises) should be recognized as a method for determining if an employee has been trained. However, it is the employee's ability to demonstrate their proficiency which should be the measure of the employee's ability to work safely. [Ex. 0212]

Other commenters objected to the proposed move away from the certification requirement, stressing the importance of recordkeeping. (See, for example, Exs. 0200, 0213, 0230, 0505.) For instance, Mr. Tommy Lucas of TVA commented:

> To ensure that employees have been trained and demonstrated proficiency, the training should be documented. Documented training is necessary for managers and supervisors to know whether or not the employee is proficient in the skills required for tasks being assigned. Having training records available to managers and supervisors will better protect employees. [Ex. 0213]

IBEW similarly supported a recordkeeping requirement for training, commenting as follows:

> The standard should require employers to record employee training. The question that needs [to be] asked is how, if training records are not kept, can an employer comply with requirements for initial and ongoing training? Most training that is offered in this industry is structured using somewhat universal subjects and methods. Those employers that are engaged in this type of training are most likely recording initial training and any other additional training that they may offer. Recording of employee training will not impose any unnecessary or costly requirement on employers that they are not currently doing. [Ex. 0230]

Mr. Donald Hartley with IBEW further explained the union's position in his testimony during the 2006 public hearing:

> OSHA should require employers to certify that employees are proficient in the tasks that they are assigned to perform and to maintain records documenting their demonstrated proficiency. There is simply no way to ensure that employers are actually certifying employees if documentation is not required. Moreover, the records can be used over time to determine whether employees have satisfied the training requirements in the past and whether retraining or recertification is necessary. [Tr. 874]

Mr. Steven Semler, counsel for ULCC, asked that OSHA retain the existing training certification requirement because it "works well . . . and has enhanced safety . . . by requiring the checkoff of certification of employees in writing" (Tr. 743). Mr. Scott Packard of Wright Tree Service testified on behalf of TCIA that the certification requirement "has clearly raised the level of safety in the line clearance tree trimming industry overall" (Tr. 751). The TCIA further commented:

> The current and existing "shall certify" language *has raised the level of safety* in the line clearance tree trimming industry as well as in non-line clearance firms with exposure to the electrical hazard and hence the need to train and to certify. This requirement is particularly important among smaller employers with less sophisticated safety programs.
>
> Requiring "certification" of employees having received the required safety training has imposed internally within line clearance contractors' and others' training procedures creation of failsafe mechanisms to unambiguously assure the employee has received the required safety training. The newly-proposed method is a more subjective—hence looser—requirement. [Ex. 0200; footnote omitted; emphasis included in original.]

Mr. Peter Gerstenberger, also testifying on behalf of TCIA, suggested that "it's the connotation of the word 'certify' that just accords the whole process more importance" (Tr. 811–812).

OSHA has carefully considered the feedback it received on this issue and has decided to adopt the requirement as proposed, without a certification requirement. OSHA believes this gives employers maximum flexibility, while still ensuring that employees have demonstrated required proficiencies. The Agency concludes that it is particularly important to provide flexibility for employers using less formal (that is, on-the-job) methods to train workers because, as noted by Messrs. Stauffer and Yancey, it could be challenging for these employers to record training that occurs sporadically and in circumstances that are not conducive to the preparation of written certifications. In addition, as noted in the preamble to the proposal, the Agency does not need training certifications for enforcement purposes under final § 1910.269 and subpart V because compliance with the training requirements can be determined through interviews with management and workers (70 FR 34835). Therefore, the Agency believes that the plain language of the final rule will be at least as effective in protecting workers as a requirement to certify these records; in this regard, the plain language of the final rule still requires employers to determine that each employee demonstrates necessary proficiencies.

OSHA also points out that Note 1 to paragraph (b)(7) specifically clarifies that the rule does not prohibit the keeping of training records. In light of the comments received, OSHA expects that some employers will voluntarily elect to prepare and maintain training records for their own purposes in tracking who has received training and demonstrated the requisite level of proficiency.

OSHA proposed a second note to paragraph (b)(7) of § 1926.950 that described how an employer may treat training that an employee has received previously (for example, through previous employment). OSHA explained in the preamble to the proposal that employers relying on training provided by others would need

to take steps to verify that the employee had been trained and to ensure that the previous training was adequate for the work practices the employee would be performing (70 FR 34835). The proposed note read:

> Employers may rely on an employee's previous training as long as the employer: (1) Confirms that the employee has the job experience appropriate to the work to be performed, (2) through an examination or interview, makes an initial determination that the employee is proficient in the relevant safety-related work practices before he or she performs any work covered by this subpart, and (3) supervises the employee closely until that employee has demonstrated proficiency in all the work practices he or she will employ.

Several rulemaking participants noted that some employees receive training from third parties, such as unions, and supported OSHA's effort to recognize the potential portability of training. (See, for example, Exs. 0162, 0169, 0234.) For example, MYR Group stated: "MYR Group . . . supports allowing reliance on prior training through demonstration of proficiency—in the circumstance of prior training not conducted by the employer a proficiency demonstration is a reasonable means of avoiding duplicative training" (Ex. 0162).

The line-clearance tree trimming industry, however, claimed that the new note would make it too difficult for an employer to rely on training that its employees received elsewhere. The tree trimmers argued that closely supervising all newly hired employees would be unworkable. (See, for example, Exs. 0174, 0200; Tr. 753–754.) For instance, Mr. Steven Semler representing ULCC argued that the note would unnecessarily require the close scrutiny of experienced and already-trained employees and suggested that the high rate of turnover in the line-clearance tree trimming industry made close supervision of all new hires administratively impractical (Ex. 0174). ULCC preferred existing § 1910.269(a)(2)(vii), which contained the training certification requirement, because, in its view, the existing standard permitted an employer to "verify the [previous employer's] certification records and observe the demonstrated proficiency of the newly hired employee staff" (*id.*). According to ULCC, "the current standard desirably enable[d] continuity of operations with trained personnel whose proficiency is determined by verification of training and observance of work" (*id.*). TCIA echoed these arguments and stated that the proposed new note "adds a new hardship to the employer without any offset whatsoever in safety" (Ex. 0200).

OSHA did not impose any new burdens on employers through proposed Note 2 to paragraph (b)(7). The proposed note simply explained one way for an employer to comply with the proficiency-demonstration requirement in final paragraph (b)(7). Tree care industry witnesses described the process they use to determine the proficiency of newly hired experienced employees, and OSHA believes that process is similar to the steps for determining proficiency that were described in proposed Note 2 (Tr. 715–717, 805–806). For example, one tree-care industry witness described his company's process for hiring an experienced employee as follows:

> [T]here would be face-to-face interviews. There will be verification of prior certifications and/or training. There will be observations done and there will be field evaluations [to verify] that . . . the certification that they claim to possess they do. [Tr. 805–806]

Although the tree care industry appears to use the process that OSHA envisioned in drafting the proposed note, OSHA reworded the note in the final rule to more closely match the process described by the tree care industry. The note in the final rule explains that for an employee with previous training, an employer may determine that that employee has demonstrated the required proficiency using the following process: (1) Confirm that the employee has the training required by final § 1926.950(b), (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 subpart V, and (3) supervise the employee closely until that employee has demonstrated the required proficiency.

The revised note makes it clearer than the proposed note that the process described in the note is not mandatory. Any process that ensures that the employee is not treated as having completed training until the employer confirms that he or she has had the training required by paragraph (b), and has demonstrated proficiency as required by paragraph (b)(7), is acceptable. The revised language also replaces the phrase "in all the work practices he or she will employ" with "as required by this paragraph" at the end of the note to make it clear that the process is designed to ensure that the employee demonstrates proficiency to the employer as required by the final rule.

Since subpart V covers some transient workers, and training is often provided by previous employers or third parties (for example, unions), some commenters suggested that employers could benefit from the development of a system for storing and accessing training information for all covered workers (Exs. 0196, 0227). EEI noted the potential value of such a system, but did not think it should be an OSHA requirement (Ex. 0227). Also, Mr. Lee Marchessault with Workplace Safety Solutions recommended that OSHA consider recognizing a universal training booklet, called a training passport in some countries, that workers would carry to prove to employers that they have been trained and have demonstrated their abilities (Ex. 0196; Tr. 573–574).

OSHA understands the third-party process by which many line workers are trained. The Agency has adopted Note 2 to paragraph (b)(7) in the final rule partly in recognition that this type of training takes place. The final rule is designed to allow employers to rely on previous training conducted by unions, previous employers, or other third parties. In fact, it would be permissible for employer groups, unions, or other third parties to design and implement a system such as the training passport recommended by Mr. Marchessault, provided that employers using the system complied with relevant OSHA training requirements. OSHA stresses that it is the employer's, not the employee's, obligation to determine that the employee demonstrates proficiency before he or she is deemed to have completed the required training.

OSHA proposed to add provisions to both subpart V and § 1910.269 concerning communication between host employers (utilities) and the contractors they hire to work on their systems.[59] As OSHA explained in the preamble to the proposal, the work covered by Subpart V is frequently done by an employer working under contract to an electric utility (70 FR 34835). Traditionally, employers with electric power generation, transmission, and distribution systems have had a workforce sufficient for the day-to-day maintenance of their systems. These employers usually hire contractors when the work to be performed goes beyond routine maintenance. Thus, contractors typically construct new transmission and distribution lines,

[59] In this discussion, OSHA uses the term "electric utility" and "host employer" synonymously. In some cases, however, the host employer may not be an electric utility. See the discussion of the definition of "host employer" later in this section of the preamble.

perform extensive renovations of transmission and distribution lines (such as replacing a large number of utility poles or upgrading a line to a higher voltage), do line-clearance tree trimming, overhaul generation plants, and repair extensive storm damage. Mr. Donald Hartley of IBEW testified at the 2006 public hearing in this rulemaking that "utilities are increasingly contracting out work, both because contractors bring expertise that the utilities do not themselves possess and as a cost-saving measure to reduce their overall payroll and overhead" (Tr. 875).

In proposing the host-contractor provisions, OSHA explained that, in many (if not all) instances, sharing of information between the electric utility employer and the contractor is necessary to adequately protect the contractor's employees from hazards associated with work on the utility's facilities (70 FR 34838–34839). For example, if the host employers and contract employers do not coordinate their procedures for deenergizing lines and equipment, then contractor employees could mistakenly believe that a line is deenergized when it is not. This mistake could have potentially fatal results for contractor employees. In a similar fashion, as OSHA also explained in the preamble to the proposal, the safety of electric utility employees is affected by the contract employer's work (*id.*). For example, a contractor's work could cause an overhead energized line to fall on a deenergized line on which an electric utility employee is working, creating hazards for the electric utility employee. Although electric utility employees do not typically work with contract employees, sometimes they do work together. For example, it is common practice for contract employees and electric utility employees to work side by side during emergency-restoration operations, such as after a big storm (Ex. 0505; Tr. 392, 1379–1380). Additionally, contractors in electric power generation plants will be working near utility employees who work in the plant (Tr. 985). The record also indicates that utility and contract employees work side by side in other situations, including during outages on transmission lines (Ex. 0505; Tr. 1380) and while working in the same substation (Ex. 0505; Tr. 313–314, 559).

Because in this host-contractor relationship the work of (or information possessed by) one affects the safety of the other's employees, OSHA believed that it was necessary for host employers and contractors to cooperate and communicate with each other to provide adequate protection for all employees maintaining or constructing electric power generation, transmission, or distribution facilities. Thus, OSHA proposed requirements in § 1926.950 (as well as in § 1910.269) to ensure the necessary exchange of information between host employers and contract employers. The requirements in the proposal were loosely based on similar provisions in the Agency's standard for process safety management (PSM), § 1910.119(h).

IBEW agreed that there was a need for host-contractor requirements in these standards, explaining that it "fully supports the basic principles underlying OSHA's proposals regarding the reciprocal obligations of the host employers and contract employers to provide one another with information necessary to safeguard their workforces" (Tr. 878).

Mr. Donald Hartley of IBEW testified about the importance of host employers and contract employers exchanging "critically important" information (Tr. 877–878). He elaborated that for contractor employees to be "equipped to deal with potential hazards associated with this dangerous work, [they require] access to information that may be in the sole possession of the host employer" (Tr. 876). He continued:

> [W]hile some contract employers report that utilities routinely provide this information with every job they contract out, as we have heard, others have found that utilities refuse to disclose that information about operating conditions even when the contract employers specifically request it.
>
> Just as the host employer possesses information critically important to the safety of contract employees, the contract employees may in the course of their work discover conditions about which the host is unaware, also recently testified to. This is particularly true when contract employees are working out in the field on equipment that the host employer may not regularly inspect. [Tr. 877–878]

OSHA received a number of comments suggesting that it should not include host-contractor provisions in the final rule. The Agency has considered these comments and concluded that, although some changes to the proposed regulatory text are necessary (as described later in this section of the preamble), the information-sharing requirements in § 1926.950(c) of this final rule are reasonably necessary and appropriate.

Some commenters took the position that the extent to which host employers and contract employers exchange information with each other is an issue best left to private contracts between the parties. (See, for example, Exs. 0149, 0151, 0159, 0172, 0179, 0188.) For example, the Lewis County Public Utility District commented:

> We feel that any arrangement between a contractor and host employer is best handled by contractual language between the two parties without OSHA involvement. This includes how the host employer and contractor communicate and exchange information. [Ex. 0149].

Evidence in the record makes clear, however, that relying on private contracts has proven to be an ineffective method of ensuring the adequate exchange of information between hosts and contractors. A number of participants at the 2006 public hearing explained that there are times when contractors are unable to get the information they need from utilities to permit the contractors' employees to work safely. For example, Mr. Donald Hartley of IBEW testified that "complying with [OSHA standards] requires access to information that may be in the sole possession of the host employer" (Tr. 876). As noted earlier, he also stated that some "utilities refuse to disclose . . . information about operating conditions even when the contract employers specifically request it" (Tr. 877). An ESCI representative agreed, testifying: "I work with a number of utility contractors that tell me that [t]here are a number of things that they are not provided that they need" (Tr. 1240). Also, MYR noted that "although . . . the transfer of information between utilities and contractors has improved tremendously over the last several years, issues still exist in the industry today" (Tr. 1333). In light of this evidence, OSHA concludes that relying on the parties' private contracts to serve this function is unlikely to ensure that host employers and contract employers receive all of the information they need to protect their workers.

Some commenters suggested that OSHA does not have statutory authority to adopt host-contractor provisions. (See, for example, Exs. 0168, 0177, 0209, 0227, 0501.) For instance, EEI commented:

> The fundamental point is that the OSH Act simply does not confer authority upon OSHA to require one employer to be responsible for the safety or health of another employer's employees. Any final rule that seeks to impose duties on host employers and contractors vis-à-vis each other will be legally vulnerable. [Ex. 0227]

OSHA has clear authority to include the host-contractor provisions in the final rule. First, the plain language of the OSH Act and its underlying purpose support OSHA's authority to place requirements on employers that are necessary to protect the employees of

others.[60] Second, congressional action subsequent to passage of the OSH Act recognizes this authority. Third, OSHA has consistently interpreted its statutory authority as permitting it to impose obligations on employers that extend beyond their own employees, as evidenced by the numerous standards, including several construction standards, that OSHA has promulgated with multiemployer provisions. Finally, OSHA's authority to place obligations on employers that reach beyond their own employees has been upheld by numerous courts of appeals and the OSHRC.

The purpose of the OSH Act is to assure so far as possible safe and healthful working conditions for every working man and woman in the nation (29 U.S.C. 651(b)). To achieve this goal, Congress authorized the Secretary of Labor to establish mandatory occupational safety and health standards. The Act broadly defines an OSHA standard as a rule that "requires conditions, or the adoption or use of one or more practices, means, methods, operations, or processes, reasonably necessary or appropriate to provide safe or healthful employment and places of employment" (29 U.S.C. 652(8)). (See *Building & Constr. Trades Dep't., AFL–CIO* v. *Brock,* 838 F.2d 1258, 1278 (D.C. Cir. 1988).) OSHA standards must prescribe measures that are appropriate to protect "places of employment;" nothing in the statutory language suggests that OSHA may do so only by regulating an employer's interactions with its own employees. On the contrary, the OSH Act's broad language gives OSHA almost "unlimited discretion" to devise means to reach the statutory goal. (See *United Steelworkers* v. *Marshall* (*Steelworkers*), 647 F.2d 1189, 1230 (D.C. Cir. 1980).)

Similarly, Section 5(a)(2) of the OSH Act provides that each employer "shall comply with occupational safety and health standards promulgated under" the OSH Act (29 U.S.C. 654(a)(2)).[61] Nothing in this language suggests that compliance is required only when necessary to protect the employer's own employees or that the employer is entitled to endanger other employer's employees at the worksite.

Section 6(b)(7) of the OSH Act specifically permits the Secretary to "prescribe the use of labels or other appropriate forms of warning as are necessary to insure that employees are apprised of all hazards to which they are exposed . . . and proper conditions and precautions of safe use or exposure" (29 U.S.C. 655(b)(7)). (Notably, the Agency's authority to require warnings is not limited to information that would warn the employer's own employees of hazards.) Finally, Section 8(g)(2) of the OSH Act generally affords the Secretary authority to "prescribe such rules and regulations as he may deem necessary to carry out . . . responsibilities under" the OSH Act (29 U.S.C. 657(g)(2)).

In short, the statute focuses on workplace conditions to effectuate the OSH Act's congressional mandate and not on a particular employment relationship. The OSH Act's underlying purpose is broad—to assure safe and healthful working conditions for working men and women—and Congress made clear that it expected the Act to protect all employees. (See H. Rep. No. 91–1291, 91st Cong., 2d Sess., pp.14–16 (July 9, 1970).) Numerous references in the legislative history of the OSH Act discuss requiring employers to provide a safe and healthful "place of employment." (See for example, S. Rep. No. 91–1282, 91st Cong., 2d Sess., p. 10 (Oct. 6, 1970).) The OSH Act tasks OSHA with promulgating rules that will create safe places of employment, notwithstanding the many varied employment relationships that might exist at a worksite.

Subsequent congressional action has also recognized OSHA's authority to impose responsibilities on employers to protect employees who are not their own. For example, Congress directed OSHA to develop a chemical process safety standard (the PSM Standard) requiring employers to "ensure contractors and contract employees are provided appropriate information and training" and to "train and educate employees and contractors in emergency response" (Pub. L. 101–549, Title III, Sec. 304, Nov. 15, 1990, 104 Stat. 2576 (reprinted at 29 U.S.C. 655 Note)). This is a clear ratification of the Agency's authority to require employers to protect the employees of others. Congress also approved of the Agency's authority when it relied on the provisions of OSHA's Hazard Communication Standard in promulgating the Emergency Planning and Community Right-to-Know Act (EPCRA), 42 U.S.C. 11001–11050. The Hazard Communication Standard requires, in part, that manufacturers and importers of hazardous chemicals provide information for the benefit of downstream employees.[62] (See 29 CFR 1910.1200; see also *Martin* v. *American Cyanamid Co.,* 5 F.3d 140, 141 (6th Cir. 1993) (noting that the Hazard Communication Standard requires "that a manufacturer of hazardous chemicals inform not only its own employees of the dangers posed by the chemicals, but downstream employers and employees as well").) Congress incorporated provisions of the Hazard Communication Standard in EPCRA as a basis for triggering obligations on owners or operators of facilities producing hazardous chemicals to provide local governments with information needed for emergency response. Had Congress not approved of the multiemployer provisions in the Hazard Communication Standard, it would not have approved of it as a basis for obligations in EPCRA.

Furthermore, OSHA has consistently interpreted the OSH Act as authorizing it to impose multiemployer obligations in its standards. In addition to the Hazard Communication Standard and the PSM Standard already noted, OSHA included multiemployer provisions in its standard for powered platforms, which requires that a building owner inform employers that the building installation has been inspected and is safe to use. (See 29 CFR 1910.66(c)(3).) OSHA also has imposed multiemployer obligations in construction standards. For example, OSHA exercised its OSH Act authority to promulgate provisions in the Asbestos Standard for the construction industry that require building owners to communicate the presence of asbestos or presumed asbestos-containing materials to certain employers with employees who may be exposed to such materials. (See 29 CFR 1926.1101(k).) In OSHA's Steel-Erection Standard, the Agency imposed duties on controlling contractors to ensure that site conditions are safe for steel erection. (See 29 CFR 1926.752(c).) More recently, OSHA promulgated rules requiring controlling entities and utilities to take steps to protect other employers' employees during crane operations. (See 29 CFR 1926.1402(c), 1926.1402(e), 1926.1407(e), 1926.1408(c), and 1926.1424(b).)

Finally, OSHA's authority to impose these provisions is confirmed by the

[60] As explained later in this section of the preamble, the overall sharing of information that will occur in accordance with the final host-contractor provisions will help protect the employees of both host employers and contract employers.

[61] This language is in marked contrast to the language of Section 5(a)(1) of the OSH Act (known as the "general duty clause"), which requires each employer to "furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees" (29 U.S.C. 654(a)(1)). (See *Brennan* v. *OSHRC,* 513 F.2d 1032, 1037–38 (2d Cir. 1975).)

[62] As a rationale for those provisions, OSHA explained that chemical manufacturers and importers are in the best position to develop, disseminate, and obtain information about their products. (See 48 FR 53280, 53322, Nov. 25, 1983.)

decisions of numerous courts of appeals and the Review Commission. For example, the Third Circuit upheld the information-sharing requirements in the Asbestos Standard for the construction industry, noting: "We are not convinced that the Secretary is powerless to regulate in this [way], especially given the findings she has made regarding the importance of building owners in the discovery and communication of asbestos hazards." *Secretary of Labor* v. *Trinity Indus., Inc.* (*Trinity*), 504 F.3d 397, 402 (3d Cir. 2007). (See also *Universal Constr. Co.* v. *OSHRC,* 182 F.3d 726, 728 (10th Cir. 1999) (following decisions from Second, Sixth, Seventh, Eighth, and Ninth Circuits holding that an employer's duties and OSHA standards may extend beyond an employer's own employees).)

EEI asserted that § 1910.12(a) precludes host-contractor requirements in subpart V, commenting:

> Section 1910.12(a), standing alone, precludes OSHA from requiring an employer covered by the final Part 1926 rule to take any responsibility for the safety of another employer's employees, certainly insofar as the final standard purports to regulate "construction." [Ex. 0227].

OSHA disagrees with EEI. Paragraph (a) of § 1910.12 provides:

> The standards prescribed in part 1926 of this chapter are adopted as occupational safety and health standards under section 6 of the Act and shall apply, according to the provisions thereof, to every employment and place of employment of every employee engaged in construction work. Each employer shall protect the employment and places of employment of each of his employees engaged in construction work by complying with the appropriate standards prescribed in this paragraph.

Paragraph (a) of § 1910.12 has no bearing on the host-contractor requirements in the final rule because the Agency clearly intends to assign specific responsibilities to host employers and contract employers, and the final regulatory text plainly reflects that intent. (See *Trinity,* 504 F.3d at 402 (rejecting argument premised on § 1910.12(a) where "the regulation at issue . . . specifically applie[d] to building owners").) Moreover, the Eighth Circuit and the Review Commission have squarely rejected EEI's argument. In *Solis* v. *Summit Contractors, Inc.* (*Summit Contractors*), the Eighth Circuit concluded that § 1910.12(a) is "unambiguous" in that it does not preclude OSHA from citing an employer when only employees of other employers are exposed to the hazard in question (558 F.3d 815, 825 (8th Cir. 2009)). The Review Commission similarly held that § 1910.12(a) does not prevent OSHA from citing a controlling employer that does not have exposed employees (*Summit Contractors, Inc.,* 23 BNA OSHC 1196 (No. 05–0839, Aug. 19, 2010)). Both the Eighth Circuit and the Review Commission emphasized the language in § 1910.12(a) establishing a duty on the part of employers to protect "places of employment" as well as employees. (See, for example, *Summit Contractors,* 558 F.3d at 824.) The first sentence in § 1910.12(a) makes the construction standards applicable to every employment and to every "place of employment" of every construction employee, and the second sentence, by providing that each employer must protect "places of employment," does not negate the broad reach of the first sentence.

Moreover, the history of § 1910.12(a) reveals that the purpose of this provision is to extend, not limit, the Agency's authority. Indeed, § 1910.12(a) is located in a subpart entitled "Adoption and Extension of Established Federal Standards," which was established to extend OSHA's authority through adoption of the Construction Safety Act's standards. (See 29 CFR 1910.11(a) ("The provisions of this subpart . . . adopt[,] and extend the applicability of, established Federal standards . . . with respect to every employer, employee, and employment covered by the Act.").) Thus, neither the language nor the context of § 1910.12(a) suggest a conflict with the information-sharing requirements in this final rule.

Some commenters asserted that the proposed host-contractor provisions inappropriately expanded or conflicted with OSHA's existing Multi-Employer Citation Policy (CPL 02–00–124 (Dec. 10, 1999)). (See, for example, Exs. 0162, 0167, 0170, 0207, 0237.)

These comments reflect a misunderstanding of both the proposal and the multiemployer citation policy. The host-contractor provisions do not rely on, or modify, the Agency's multiemployer enforcement policy. (See *Trinity,* 504 F.3d at 402 (distinguishing an enforcement action under the multiemployer provisions of the Asbestos Standard for construction from cases in which the Agency invoked the multiemployer citation policy).) Rather, the multiemployer citation policy and the host-contractor provisions represent separate exercises of OSHA's statutory authority to protect places of employment. The host-contractor provisions and the multiemployer enforcement policy operate in different, yet entirely consistent, ways to permit the Agency to fulfill its statutory mission.

OSHA's multiemployer citation policy simply recognizes the existing responsibilities of different employers at multiemployer worksites under the Act and OSHA standards. For example, employers have a duty not to create hazardous conditions that violate OSHA standards, regardless whether it is their own employees or another employer's that they endanger. (Employers who do so are referred to as "creating employers.") And employers have a duty to protect their own employees from violative conditions, even if created by another employer. Such "exposing employers" must take reasonable steps to correct the hazards or otherwise protect their workers. Similarly, "controlling employers," that is, employers with general supervisory authority over safety and health at a worksite, by virtue of that authority, have certain responsibilities to prevent and detect violations affecting employees at the workplace.

When OSHA promulgates new safety and health standards, it does so against this background principle that employers share responsibility for working conditions, and thus for OSHA compliance, at multiemployer worksites. Therefore, when the Agency issues a new safety or health standard, it is with the intention that creating, exposing, and controlling employers at multiemployer worksites will exercise their respective responsibilities to ensure that affected employees are protected as required by the standard.

In some situations, however, the general background principles reflected in the multiemployer policy will not be sufficient to ensure the safety of workplaces; in those instances, OSHA may find it necessary to impose additional or more specific obligations on particular employers to protect workers. The host-contractor provisions in this final rule, as well as similar information-sharing provisions in the Hazard Communication Standard, the PSM Standard, and the Asbestos Standard for construction, are examples of the Agency regulating in this manner. In this rulemaking, OSHA determined that the final host-contractor provisions are necessary, in addition to the general background responsibilities employers have, to ensure the safety of affected employees. Not all utilities (or host employers) will have sufficient authority over, or relationships with, contractor worksites to qualify as controlling employers under the multiemployer citation policy. In addition, the final rule prescribes with specificity the information-sharing responsibilities of hosts and contractors. The specific information-sharing

requirements in the host-contractor provisions are necessary to ensure that critical information sharing and coordination take place at all workplaces where employees perform work covered by the final rule.

Some commenters argued that the host-contractor provisions could create employer-employee relationships between host employers and contractor employees. (See, for example, Exs. 0173, 0178.) For instance, the Farmers Rural Electric Cooperative Corporation commented:

> It is up to the contractor and the employees of that firm to perform this work, under their supervision and direction, using their work practices and safety rules. Should we as hosts begin to direct their work, provide supervision of that work, oversee their safety practices, the IRS would then say they are our employees and are entitled to benefits. [Ex. 0173]

Also, some commenters suggested, more generally, that the host-contractor provisions could expand the potential legal liability of the respective employers. (See, for example, Exs. 0168, 0187, 0220, 0226.) A few commenters argued that in these ways the proposed host-contractor provisions went so far as to violate the OSH Act. For example, the National Association of Home Builders commented:

> [W]e also believe that OSHA's multi-employer language in the proposed rule in Subpart V impermissibly expands the common law liability of host/general contractors in violation [of Section 4(b)(4)] of the OSH Act. [Ex. 0168].

OSHA concludes that, under any of the potentially applicable legal tests for an employment relationship, the final host-contractor provisions are unlikely to result in one employer exercising the type or degree of control over the employees of another employer that would create an employer-employee relationship when one otherwise would not have existed. (See, for example, *Nationwide Mutual Ins. Co* v. *Darden,* 503 U.S. 318 (1992) (common-law test for determining who is an "employee"); *Antenor* v. *D&S Farms,* 88 F.3d 925 (11th Cir. 1996) (factors relevant to determining whether two employers are "joint employers" of an individual employee for purposes of the Fair Labor Standards Act); *Weber* v. *C.I.R.,* 60 F.3d 1104 (4th Cir. 1995) (test for determining whether there is an employment relationship for income tax purposes).)

OSHA also disagrees with the commenters' claim about Section 4(b)(4) of the OSH Act. That provision states:

> Nothing in [the OSH] Act shall be construed to . . . in any manner affect any workmen's compensation law or to enlarge or diminish or affect in any other manner the common law or statutory rights, duties, or liabilities of employers and employees under any law with respect to injuries, diseases, or death of employees arising out of, or in the course of, employment. [29 U.S.C. 653(b)(4)]

This provision serves two purposes: First, it establishes that the OSH Act does not create a private right of action. (See, for example, *Crane* v. *Conoco, Inc.,* 41 F.3d 547 (9th Cir. 1994).) Second, it makes clear that the duties and liabilities imposed under the OSH Act do not displace the duties and liabilities that exist under State tort and workers' compensation schemes. (See, for example, *Frohlick Crane Serv., Inc.* v. *OSHRC,* 521 F.2d 628 (10th Cir. 1975).)

OSHA acknowledges that State courts are free to permit the use of OSHA regulations, including these final host-contractor provisions, as evidence of a standard of care in a negligence action. (See, for example, *Knight* v. *Burns, Kirkley & Williams Constr. Co.,* 331 So.2d 651 (Ala. 1976).) However, it does not follow that regulations used in that fashion are invalid under Section 4(b)(4) on the ground that they expand employers' common-law liabilities, a result that would limit the Secretary's rulemaking authority to issuing regulations that codify duties already owed by employers at common law. Such a result would be inconsistent with Congressional intent in promulgating the OSH Act, and no court has ever invalidated an OSHA regulation on the ground that it violates Section 4(b)(4). Indeed, courts have squarely rejected the argument that Section 4(b)(4) precludes multiemployer enforcement practices. For example, in *Summit,* the Eighth Circuit concluded that OSHA's multiemployer citation policy did not violate Section 4(b)(4), explaining that even though it could "increas[e] an employer's liability at common law[,]" the policy "neither creates a private cause of action nor preempts state law" (558 F.3d at 829). (See also *Steelworkers,* 647 F.2d at 1234–36.)

OSHA decided to adopt the proposed host-contractor provisions, with some substantial modifications (described later in this section of the preamble), in the final rule. Before addressing each specific provision, however, OSHA must first address the scope of these requirements.

The proposal defined a "host employer" as "[a]n employer who operates and maintains an electric power transmission or distribution installation covered by subpart V of this Part and who hires a contract employer to perform work on that installation." This definition included electric utilities and other employers that operate and maintain electric power transmission or distribution installations. However, it did not include employers that own, but do not operate and maintain, such installations. The Agency believed that entities that do not operate or maintain these installations would generally not have the expertise necessary to work safely on transmission or distribution lines and equipment and would have little hazard-related knowledge to pass on to contractors. In addition, the employees of such entities would have little if any exposure to hazards created by a contract employer. The Agency invited comments on whether excluding such employers from the host-contractor provisions would unduly jeopardize employee safety and whether any of the host-contractor provisions could reasonably be applied to such employers.

Some commenters, such as Energy United EMC (Ex. 0219), supported the proposed exclusion of owners that do not operate or maintain installations. Ohio Rural Electric Cooperatives commented: "If an employer only owns but does not actually operate its own lines or equipment then that employer would certainly not be able to pass on any useful information to a contractor" (Ex. 0186).

IBEW took the position that "[e]xcluding such employers from any host-contract employer provisions, in general, should not jeopardize employee safety," but questioned whether those entities may make "decisions on how the system will be operated, such as switching procedures and load transfer, that . . . could have a direct impact on worker safety" (Ex. 0230). The union went on to suggest that "[w]hatever entity has the responsibility and/or decision making power as to how the system is operated should be included in the proposed provisions" (*id.*).

Others commented that the host-contractor provisions should apply to all system owners. Ms. Susan O'Connor of Siemens Power Generation commented, for example, that excluding owners that do not perform operations or maintenance could jeopardize employee safety "in situations where host employers might use this provision as a loophole to avoid regulation" (Ex. 0163). Ms. O'Connor suggested that a utility could "eliminate [its] qualified maintenance department and outsource . . . maintenance to avoid dealing with this regulation" (*id.*). MYR Group also "believe[d] that the protections afforded to contractors through the host employer obligations should apply

regardless of whether the host actually operates the installation" (Ex. 0162). MYR thought that "[s]erious and inequitable problems could arise from failure to apply the proposed rule requirements on host employers that own but do not operate their electric utility installations" (*id.*).

OSHA considered the record and concludes that the host employer should be the employer that is in the best position to have information on the design, operation, and condition of an electric power generation, transmission, or distribution system. Based on this principle, OSHA decided that an employer that controls how the system is operated, such as switching procedures and load transfer, should not be excluded from the host-contractor provisions. Depending on the type of work practices used, such operational control could have a direct impact on worker safety. For example, an employer that controls the operation of an electric power generation, transmission, or distribution system could institute new switching procedures without informing contractors or coordinating the new procedures with contractors (Ex. 0230). In addition, because an employer, to fall within the proposed definition of "host employer," needed to operate and maintain the installation *and* hire the contractor, it would have been possible under the proposal to have scenarios in which there was no host employer, such as if one employer owned the installation (and hired the contractor) and a different employer operated or maintained the installation. This result could have undermined the information-sharing requirements altogether.

The Agency is revising the definition of "host employer" to include employers that operate installations or control procedures for operation of installations without regard to whether the employer owns the installation. In addition, OSHA is deleting the reference to "maintenance" in the final definition of "host employer" because the Agency believes that an employer that only maintains an electric power generation, transmission, or distribution system is unlikely to have knowledge of the design, operation, and condition of the installation; employers that perform such maintenance may be contractors hired by an electric utility. (See, for example, Tr. 403, 1200–1201.) Maintenance contractors will need information from the employer that operates or controls the operation of the installation, as would any other contractor. The final rule states that 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 is a host employer. A note to the definition of "host employer" provides that OSHA will treat the electric utility or the owner of the installation as the host employer if it operates or controls operating procedures for the installation. If the electric utility or installation owner neither operates nor controls operating procedures for the installation, OSHA will treat the employer that the utility or owner has contracted with to operate or control the operating procedures for the installation as the host employer. In no case will there be more than one host employer. (See the definition of "host employer" in final § 1926.968.)

The revised definition incorporates IBEW's recommendation that the Agency focus on the entity that has control over the system. OSHA believes any such entity is likely to have critical safety-related information about the system. In addition, the revised language renders Ms. O'Connor's comment moot; the revised language ensures that an entity that is in a position to have information that affects the safety of contractor employees will be identified as a host employer under the final rule.[63] Note that OSHA has added electric power generation installations to the installations covered by the definition of "host employer" in subpart V for consistency with the definition of this term in § 1910.269.

In addition, the definition in the final rule removes the criterion that the host employer be the entity that hires the contractor. The record indicates that various entities hire contractors to work on electric power generation, transmission, and distribution installations. For example, utility owners hire contractors to perform maintenance (Ex. 0186; Tr. 403). In addition, some contractors subcontract some of their work (Tr. 315–316, 1380–1381). Subcontractors will be treated as "contract employers" under the final rule even though the host does not hire them directly.[64] The standard's information-exchange requirements hinge on the need to exchange information between the entity that operates or controls operating procedures for the system and entities that are performing maintenance or construction work on the system. The type of contractual relationship that exists between the host employer and contract employers does not change the need for this information exchange. OSHA realizes that the final rule will require some employers to exchange information with entities with which they have no direct contractual relationship. These employers can either exchange information directly with each other or can arrange to handle their information exchange through contacts with entities that *do* have contractual relationships with the other employer. For example, an electric utility transmitting information to an employer under contract to perform work on the installation could instruct (or contract for) that contractor to share the same information with any subcontractors hired to perform work under the contract. Ultimately, however, it is the host employer's responsibility to ensure that whatever procedures it uses are adequate to get the required information to all "contract employers" working on the installation. Paragraph (c)(3) of final § 1926.950 (discussed later in this section of the preamble) requires host employers and contract employers to coordinate their work rules and procedures; part of this coordination involves establishing appropriate procedures for exchanging information in accordance with the host-contractor provisions.

The other issue involving coverage under the host-contractor provisions pertains to line-clearance tree trimming. OSHA proposed to exclude from the host-contractor requirements work done by line-clearance tree trimmers who are not qualified employees. As discussed earlier in this section of the preamble, line-clearance tree-trimming work is covered by § 1910.269. Paragraph (a)(1)(i)(E)(*2*) of existing § 1910.269 lists the paragraphs of that section that apply to work performed by line-clearance tree trimmers who are not qualified employees, and OSHA did not propose to add the host-contractor provisions to that list.

By not proposing to modify existing § 1910.269(a)(1)(i)(E)(*2*), OSHA would not have applied the host-contractor provisions to line-clearance tree-trimming operations performed by unqualified employees. However, as long as qualified employees are using electrical protective equipment, these employees would be permitted to come much closer to energized parts than unqualified employees. The Agency believed that qualified employees

[63] The definition of host employer in the final rule also removes any confusion over whether a holding company that owns a utility company's outstanding stock, which is a common practice, or the electric utility itself "owns" the installation.

[64] As explained later in this section of the preamble, "contract employer" is defined as: "An employer, other than a host employer, that performs work covered by subpart V of this part under contract."

performing line-clearance tree-trimming work in proximity to energized lines and equipment face hazards similar to contract power line workers and should receive similar protection.[65]

OSHA requested comments on whether its proposed approach for dealing with line-clearance tree-trimming work under the host-contractor provisions unduly jeopardized employee safety and whether any of the host-contactor provisions could reasonably be applied to tree-trimming work performed by line-clearance tree trimmers who are unqualified employees. Many commenters supported OSHA's proposal. (See, for example, Exs. 0126, 0174, 0177, 0200, 0201, 0213, 0219, 0227.) For instance, EEI agreed "that line clearance tree-trimming contractors should be excluded from the requirement," explaining: "Host utilities are usually not familiar with the hazards associated with trimming trees and routinely rely on the expertise of the line clearance tree-trimming contractors to perform that work in a manner which ensures the safety of their employees" (Ex. 0227). These comments were echoed by ULCC, which "commended" OSHA's proposal to exclude work done by line-clearance tree trimmers who "do not work on or touch electric supply lines" from the host-contractor provisions (Ex. 0174). ULCC urged the Agency to maintain this exclusion in the final rule, commenting:

> [T]he wisdom of the exclusion is manifest: for, the rationale of the proposed "host-contractor" provisions . . . is to apply the utilities' expertise to utility contractors performing utilities' typical work—in effect, to force down utilities' safety expertise onto their *electric-work contractors* in order to raise the safety experience rate of those contractors to the better safety rate of the utilities who employ them. Such policy-driver for applying "host-contractor" to utility contractors performing electric utility (i.e. lineman) "qualified" work, simply is inapplicable to line clearance work: for, the utilities hire line clearance contractors because line clearance contractors are arborists who are specialists in vegetation management—precisely skills which the utilities contract out because they typically do not have that expertise in tree growth, tree trimming techniques, tree rigging, tree removal, vegetation management, etc. In short, utilities simply do not have the institutional expertise of line clearance tree knowledge to develop and direct line clearance safety practices of line clearance contractors via "host-contractor" provisions. . . . So, the "force-down" premise of "host-contractor" simply does not apply to line clearance. [*Id.;* emphasis included in original.]

Duke Energy commented that "[t]here should be no expectation that host employers provide information on tree-trimming hazards to line-clearance tree trimming contractors," suggesting that "[a]pplying the host-contract employer provisions [in the context of line-clearance tree trimming] will be very difficult" (Ex. 0201).

Some commenters, however, advised against the proposed exclusion and argued that all line-clearance tree trimmers should be covered by the host-contractor provisions. (See, for example, Exs. 0162, 0186, 0230, 0234.) IBEW, for instance, commented:

> Line-clearance tree-trimming work could, in some instances, be affected by the host employer[']s operation of the system. Lockout/Tagout procedures during service restoration are one example where contractor employee safety could be jeopardized if line-clearance tree-trimming contractors are excluded from all provisions of the proposed host-contract employer provisions. At a minimum, information regarding circuit conditions, changes in conditions, and lockout/tagout applications should be communicated by the host employer to the contractor employer. [Ex. 0230]

The Ohio Rural Electrical Cooperatives agreed, also suggesting that all line-clearance tree trimmers be covered by the host-contractor requirements. That organization explained that tree trimmers "might not need as much information as a line contractor but they still need to know for sure which lines are energized, which are on single-shot protection, etc." (Ex. 0186). Mr. Wilson Yancey of Quanta Services noted that "[w]hether an employee is qualified or not, hazards will exist that are unique to the host employer" (Ex. 0234). He believed that the proposal to leave some line-clearance tree trimmers out of the host-contractor requirements was "not well-founded and might unduly jeopardize employee safety" (*id.*).

The Agency recognizes that line-clearance tree trimmers do not face exactly the same hazards as line workers. However, the record indicates that host employers have information that line-clearance tree trimmers need so that they can perform their work safely (Ex. 0505; Tr. 642–643, 686–688, 775). For example, Mr. Mark Foster of Lucas Tree Experts testified that line workers will generally inform tree crews that a line is about to be reenergized (Tr. 642–643). In addition, ULCC's posthearing brief indicated that "line clearance tree trimmers necessarily must rely upon information from utility representatives that the line has been deenergized, isolated and grounded when those procedures are appropriate" and that the "safety of line clearance tree trimmers would be enhanced by . . . utilities being required, by OSHA standard, to give [certain] information to line clearance tree trimmers" (Ex. 0502).

Not only do line-clearance tree trimmers need information from utilities, but line-clearance tree trimming contractors often have important safety information for utilities, for example, information they discover in the course of work about hazardous conditions that could affect utility employees. Such conditions can include downed power lines, transformer problems, and insulator and pole issues (Tr. 665, 689–690, 787–788).

Upon considering the record, it has become apparent to OSHA that: (1) There is a need for information exchange between host employers and tree-trimming contractors and (2) the host-contractor provisions should apply to all line-clearance tree trimming. Therefore, the Agency added § 1910.269(a)(3) to the list of paragraphs denoted in final § 1910.269(a)(1)(i)(E)(2) to cover line-clearance tree-trimming operations performed by line-clearance tree trimmers who are not qualified employees.

As noted earlier, some commenters maintained that utilities hire contractors for their expertise and knowledge about particular hazards and rely on those contractors to use that expertise to protect their (that is, the contractors') own employees. (See, for example, Exs. 0127, 0172, 0173, 0177, 0200, 0207, 0227.) For instance, Mr. Frank Brockman with Farmers Rural Electric Cooperatives Corporation stated, "We, as host employers, hire contractors to do specific jobs, often that we do not have the knowledge, expertise, equipment or manpower to accomplish." He maintained that "[c]ontractors are responsible for their employees' safety" (Ex. 0173). SBA commented that "the host is usually not present at these worksites and often does not possess expertise in the type of work being performed" and noted that "many of the SERs questioned whether the host-contractor provisions are appropriate for the electric power industry at all" (Ex. 0207).

Some comments specifically addressed the issue of whether line-clearance tree trimming firms should be covered by the host-contractor provisions. For example, Consumers Energy stated, "Host utilities are usually not familiar with the hazards associated with trimming trees and routinely rely

[65] For a full discussion of why § 1910.269 applies different requirements to line-clearance tree-trimming operations depending on whether they are performed by qualified or unqualified employees, see the preamble to the 1994 § 1910.269 final rule (59 FR 4336).

on the expertise of the line clearance tree-trimming contractors to perform that work in a manner which ensures the safety of their employees" (Ex. 0177). In addition, TCIA stated:

> OSHA makes the correct assertion that the utility must have a shared expertise with the contractor in order to specify its safety standards for the contractor to follow. In stark contrast, utilities typically contract line clearance tree trimming because of their *lack of expertise* in that subject. [Ex. 0200; emphasis included in original]

OSHA recognizes that contractors may have specific expertise that host employers do not have. However, the Agency does not believe that this is a valid reason not to require the type of information exchange required by the final rule. As noted earlier, electric utilities have information about their systems that the contractors do not have. The Agency also believes that contractors, especially those hired for expertise in a particular area, have information about hazardous conditions related to their work that host employers do not have (for example, the dangers posed to the host employer's employees from chippers and falling tree limbs). In addition, when one employer's activities may endanger another employer's employees, the Agency believes that it is essential for the two employers to coordinate their activities to ensure that all employees are adequately protected. For example, as noted later in this section of the preamble, it is important for an electrical contractor to coordinate procedures for deenergizing and grounding lines and equipment with the host employer. Similarly, it is important for line-clearance tree trimming firms to coordinate their work with host employers and to inform host employers of hazardous conditions posed by the tree-trimming work to ensure that the host employers' employees are not exposed to tree-trimming hazards about which those employees have received no training.

OSHA proposed to define "contract employer" as "[a]n employer who performs work covered by subpart V of this part for a host employer." OSHA did not receive any significant comment on this definition. However, OSHA is revising the definition to include any "work covered by subpart V of this part under contract" rather than just work "for a host contractor." This revision correlates the definition of "contract employer" with the revised definition of "host employer," which no longer provides that an employer must "hire" another employer to be a host employer. This revision makes it clear that an employer performing subpart V work under contract is covered as a "contract employer" by the host-contractor provisions in final paragraph (c) regardless of whether the entity for which the work is being performed is the "host employer" or another "contract employer." Contract employers under the final rule may include painting contractors, line-construction contractors, electrical contractors, and any other contractors working on the construction of electric power transmission and distribution lines. (For final § 1910.269, contract employers will also include contractors working on covered electric power generation installations, such as boiler-maintenance contractors, conveyor-servicing contractors, and electrical contractors.) The definition of "contract employer" does not include contractors that might be present at a jobsite where some work performed is covered by subpart V, but that are not performing covered work.

Paragraph (c) of final § 1926.950 contains requirements for the transfer of information between host employers and contract employers. In the proposal, OSHA entitled this paragraph "Contractors." After considering the comments received, the Agency concludes that the proposed title does not reflect the true scope of the paragraph's provisions. The title at final § 1926.950(c) is being changed to "Information transfer" to more appropriately describe the requirements contained in the paragraph.[66] In addition, the final rule does not include proposed § 1926.950(c)(1)(ii), which would have required host employers to report observed contract-employer-related violations of this section to the contract employer. Consequently, OSHA renumbered proposed paragraph (c)(1)(i) (and subordinate paragraphs (c)(1)(i)(A) and (c)(1)(i)(B)) as final paragraph (c)(1) (and subordinate paragraphs (c)(1)(i) through (c)(1)(iv)).

Proposed paragraph (c)(1)(i) required host employers to provide certain information to contract employers. Paragraph (c)(1)(i)(A), as proposed, required host employers to provide contractors with information about "[k]nown hazards that are covered by this section, that are related to the contract employer's work, and that might not be recognized by the contract employer or its employees." The purpose of this provision was to ensure that contractors could take measures to protect their employees from hazards posed by hosts' workplaces. Although this proposed provision would not require hosts to inform contract employers of hazards that contract employees are expected to recognize, such as hazards posed by an overhead power line, the proposal provided that hosts inform contract employers of hazards known to the hosts that might not be recognized by the contractors. For example, if a host employer knew that a particular manhole on its system was subject to periodic contamination from a nearby fuel tank, the host was to share this information with the contractor.

OSHA received considerable feedback on this proposed requirement. (See, for example, Exs. 0146, 0159, 0160, 0167, 0175, 0178, 0186, 0201, 0227, 0234, 0480, 0505; Tr. 1333–1334.) Some commenters agreed with the proposal to require host employers to inform contractors of known hazards. (See, for example, Exs. 0167, 0169, 0234; Tr. 1333–1334.) For example, the Iowa Association of Electric Cooperatives commented that its members supported proposed paragraph (c)(1)(i)(A), explaining that "[i]t is . . . common practice for Iowa's cooperatives to inform their contract employers of hazards that are related to the contract employer's work that might not be recognized by the contract employer or its employees" (Ex. 0167).

However, most of the comments on this provision objected to the proposed language. The most common complaint was that the proposed language was too broad or vague. (See, for example, Exs. 0146, 0175, 0178, 0201, 0227.) For instance, EEI commented:

> This proposal is impermissibly vague because it fails to provide adequate notice of what would constitute compliance. *See, e.g., Ga. Pac. Corp.*, v. *OSHRC*, 25 F.3d 999 (11th Cir. 1994). For example, what are hazards "that are covered by this section?" Considering that the proposed standards incorporate the requirements of many standards other than those addressed in the proposal, would host employers be required to inform contractors of known hazards addressed by all potentially applicable standards? Even if the term is confined to the standards under consideration here, this is a vastly overbroad requirement.
>
> Next, what is the test for determining the hazards that are "related" to the contractor's work? Further, on what objective basis is a host employer to determine which hazards might not be recognized by the contract employer or its employees? Does this mean that the host must be sufficiently familiar with the training of a specialty contractors' employees to allow an intelligent assessment

[66] The title of this provision is "Information transfer." However, throughout the rulemaking, the Agency and the regulated community referred to the provision as the "host-contractor provision," as the provision contains information-transfer requirements for host employers and contract employers. OSHA, therefore, uses the terms "information-transfer provision" and "host-contractor provision" interchangeably when referring to this provision.

of what hazards those employees "might" or "might not" recognize? What will be the penalty for mis-evaluating these possibilities, if made in good faith?

Indeed, what are "hazards" for purposes of this rule? Are they limited to conditions and practices that pose a significant risk of injury to employees, and would the likelihood of occurrence and degree of gravity make a difference? Similarly, what are "known" hazards? Are they hazards that the host employer actually knows of, or are they hazards that a host employer should have known through the exercise of reasonable diligence? Does actual knowledge for this purpose mean knowledge of any hazard that can be discerned by searching a company's records—a daunting test for an electric utility that may have decades of records related to work on transmission and distribution facilities that cover literally thousands of square miles—or is a more realistic test to be applied? If so, what is it? [Ex. 0227]

Mr. James Shill with ElectriCities similarly commented that the proposed provision would 'require ElectriCities' members to take into account every section of the OSHA standards, as well as others incorporated by reference, and make a 'guess' as to all of the potential hazards a contractor may be unable or unwilling to 'recognize' (Ex. 0178). Ms. Salud Layton with the Virginia, Maryland & Delaware Association of Electric Cooperatives argued that "[t]he phrase 'might not be recognized by the contract employer or its employees' is too broad" and suggested that the proposed paragraph be revised to "specifically state the items that must be provided by the host employer to the contract employer" (Ex. 0175).

Some commenters proposed new language for this provision. (See, for example, Exs. 0201, 0227, 0505.) For instance, EEI suggested:

[T]he final rules should be limited to requiring that a host employer notify a contractor of a hazard where: (1) The host employer has actual knowledge: (a) That the hazard is present, and (b) that the contractors' employees are likely to encounter the hazard in performing the work for which the contractor is engaged; (2) given its known expertise, the contractor cannot reasonably be expected to recognize the hazard; and (3) for this purpose, the "hazard" is a condition or practice that poses a significant risk of death or serious physical harm to the contractor's employees. The standard should also make clear that the host employer is not obligated to evaluate each job assigned to a contractor to determine whether such hazards are presented. [Ex. 0227]

IBEW, although generally supporting this and the other proposed host-contractor requirements, also suggested changes to paragraph (c)(1)(i)(A). The union proposed:

The host employer shall inform the contract employer of . . . existing or reasonably anticipated hazards covered by this subsection (i) of which the host employer is aware, (ii) that are related to the contract employer's work, and (iii) that are sufficiently unique to the host employer's operations or premises that the contract employer or its employees would not, through the exercise of reasonable care, be expected to recognize. [Ex. 0505]

Mr. Donald Hartley with IBEW explained:

It is important . . . to require the host employer to disclose hazardous conditions that it knows actually exist and that it reasonably anticipates may exist. The point here is to include hazards that may exist intermittently: for example, switching surges or environmental conditions or only under certain circumstances that, when they occur, affect the workplace safety.

Second, the focus of the information disclosure should be on information that is sufficiently unique to the host's workplace or operations that the contract employer cannot be expected to know without the input from the host employer. A contractor may be unable to identify hazards not only because it lacks the technical expertise, but for the very basic reason that it is unfamiliar with the unique features of the host's operation or workplace environment. Again, environmental conditions or specific operating procedures are examples of this.

Finally, we believe that host employers should be required to disclose any hazards that threaten contractor employees with any illness or injury, not just death or the most serious of physical harm. [Tr. 879–880]

OSHA considered the comments on proposed paragraph (c)(1)(i)(A) and continues to believe that the final rule should include a requirement for host employers to convey certain information to contractors that will bear on the contractor's ability to ensure the safety of its employees. Much of the opposition to this provision was to the specific language in the proposal, not to the general principle that utilities have safety-related information that should be shared with contractors.

OSHA is sensitive to the concerns of commenters who noted that the proposed language was overbroad or unclear. Therefore, OSHA revised the final rule to more clearly define the information host employers must provide to contractors. The Agency is linking the information-transfer requirements, in part, to the requirement in final § 1926.950(d) for determining existing conditions. (Paragraph (d), discussed later in this section of the preamble, is essentially the same as existing § 1910.269(a)(3).) In the final rule, § 1926.950(d) requires a determination of the existing characteristics and conditions of electric lines and equipment related to the safety of the work. The examples of "existing conditions" that were listed in proposed paragraph (d) have been separately numbered in final paragraph (d). The first five items of information listed in final paragraph (d) are "characteristics" of the electric power installation. The remaining three items of information listed in final paragraph (d) are "conditions" at those installations. Therefore, paragraphs (c)(1)(i) and (c)(1)(ii) of the host-contractor provisions in the final rule refer to (and require the sharing of) information about the characteristics and conditions specifically listed in final paragraph (d) that are related to the safety of the work to be performed.

Contract employers may request from the host employer information they need to protect their employees, in addition to the information that host employers must provide under final paragraphs (c)(1)(i) through (c)(1)(iii).[67] Thus, final paragraph (c)(1)(iv) requires host employers to provide contractors with information about the design or 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.

As already noted, OSHA decided to adopt language in paragraphs (c)(1)(i) and (c)(1)(ii) in the final rule that more clearly specifies the information that host employers must provide to contractors and does so by using language that is familiar to employers complying with existing § 1910.269.[68] Paragraph (d), discussed later in this section of the preamble, lists specific characteristics and conditions of electric lines and equipment that must be determined before work on or near electric lines or equipment is started when these characteristics and conditions are related to the safety of the work to be performed. These characteristics and conditions include the nominal voltages of lines and

[67] Final paragraph (c)(1)(iii), discussed later in this section of the preamble, requires host employers to provide contractors with information about the design and operation of the host employer's installation that the contract employer needs to make the assessments required by subpart V.

[68] It should be noted that, in revising the language of this provision in the final rule, OSHA did not conclude that the proposed language was overbroad or too vague. Similar language is used in other OSHA standards, including the standard for process safety management of highly hazardous chemicals (see § 1910.119(h)(2)(ii)). The Agency believes that employers subject to that rule are successfully complying with it. However, OSHA is revising the language of this provision in Subpart V because it resolves rulemaking participants' concerns about the proposed provision in a manner that adequately protects employees and is more consistent with existing requirements for electric power generation, transmission, and distribution work in § 1910.269.

equipment, maximum switching transient voltages, the presence and condition of protective grounds and equipment grounding conductors, and the condition of poles. Host employers are the parties that possess much of this information, and it would be difficult in many cases (and impossible in others) for contract employers to determine these conditions and comply with paragraph (d) without getting the necessary information from the host employer.

For example, an electrical contractor might be able to make a reasonable estimate of the nominal voltage on a line through examination of the equipment. However, having the host employer provide that information to the contractor eliminates guesswork and the hazards associated with inaccurate estimates.

Similarly, contractors will usually be unable to determine the maximum switching transient overvoltages on a power line without information from the host employer. The maximum per-unit transient overvoltage determines the minimum approach distance for workers to maintain from exposed, energized parts (see the discussion of this issue under the summary and explanation of final § 1926.960(c)(1) later in this section of the preamble). Without this information from the host, a contractor might not adhere to the proper minimum approach distance and, as a result, a power line worker might come too close to the power line and be at risk of serious injury from electric shock and burns.

Paragraph (c)(1)(i) of the final rule provides that, before work begins, the host employer must inform the contractor of 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). These characteristics are: the nominal voltages of lines and equipment, the maximum switching-transient voltages, the presence of hazardous induced voltages, the presence of protective grounds and equipment grounding conductors, and the locations of circuits and equipment, including electric supply and communication lines and fire-protective signaling circuits.[69] OSHA presumes that host employers have this information because they typically need it for the design and operation of an electric power generation, transmission, or distribution system. A note to final paragraph (c)(1)(i) explains that in an unusual case in which the host employer does not have this information in existing records, it must obtain the information for purposes of complying with paragraph (c)(1)(i).

Paragraph (c)(1)(ii) of the final rule requires that, before work begins, the host employer inform the contract employer of the conditions of the host employer's installation that are related to the safety of the work to be performed, that are listed in final paragraphs (d)(6) through (d)(8), and that are known to the host employer. These conditions are: the condition of protective grounds and equipment grounding conductors, the condition of poles, and environmental conditions relating to safety. Final paragraph (c)(1)(ii) only requires host employers to provide known information to contractors. Host employers gain information on the condition of their electric power generation, transmission, and distribution systems through normal preventive-maintenance inspections; and, if host employers find conditions listed in final paragraphs (d)(6) through (d)(8) and related to the safety of work to be performed by a contractor during such inspections, the host employer must pass that information to the contract employer under final paragraph (c)(1)(ii). For example, if a utility conducts a wood-pole inspection program and finds several poles that are structurally unsound and that need replacement, this information must be imparted to a contractor whose work involves the affected poles. However, this paragraph only requires the host employer to provide information that the host can obtain from existing records through the exercise of reasonable diligence; this provision does not require host employers to conduct inspections to identify these conditions. To make this clear in the final rule, OSHA included a note following paragraph (c)(1)(ii) clarifying that, for the purposes of that paragraph, the host employer does not have to inspect of worksite conditions or otherwise get information that it cannot obtain through a reasonably diligent search of its existing records.

OSHA believes that the revised language in paragraphs (c)(1)(i) and (c)(1)(ii) of the final rule addresses the concerns expressed by commenters, such as ElectriCities and EEI, about the clarity and scope of proposed paragraph (c)(1)(i)(A). The provision no longer requires host employers to determine whether a hazard exists or whether contractors might be expected to recognize particular hazards.

Under final paragraph (c)(1)(iv), before work begins, a host employer must provide additional information about the design or operation of the installation, but only if that information (1) is known by the host employer, (2) is requested by the contract employer, and (3) is related to the protection of the contract employer's employees. A note to final paragraph (c)(1)(iv) clarifies that, for purposes of complying with that paragraph, the host employer is not required to make inspections or otherwise get information that it cannot obtain through a reasonably diligent search of its existing records.

IBEW commented that, "[i]n addition to the information about 'existing conditions' needed to perform the hazard analysis, there may be other information unique to the host's operations or premises that the contractor employer needs to ensure the safety of its employees" (Ex. 0505). The union identified "schedules of other crews that may be working on the same circuits or equipment, anticipated operational changes, and the potential impact of unique localized climatic, environmental or geological conditions" as examples of such information (*id.*). Details about the scheduling of outages is another example of information a contractor might need to obtain from the host employer before employees start work.

OSHA is not explicitly requiring host employers to provide this other type of information to contractors. The Agency believes that, although information such as the scheduling of crews may prove useful in some situations, it is not always essential to ensure the safety of employees. When a contractor needs this information to protect its employees, the contractor may request this type of information under final paragraph (c)(1)(iv). In addition, OSHA believes that host employers and contract employers will exchange this type of information in their efforts to comply with other provisions in final paragraph (c). For example, when host and contractor crews will be working together or on the same circuit, OSHA intends for both employers to exchange crew-scheduling information when necessary to comply with final paragraph (c)(3) (discussed later in this section of the preamble), which requires the contract employer and the host employer to coordinate their work rules and procedures to ensure that employees are protected as required by subpart V.

As a general matter, OSHA does not believe that the information host

[69] In final § 1926.950(d)(5), OSHA changed the proposed term "power . . . lines" to "electric supply . . . lines." The two terms are synonymous, and the final rule defines "electric supply lines" in § 1926.968. Note that lines that employees encounter are either electric supply lines, communication lines, or control lines, such as those on fire-protective signaling circuits.

employers must share with contract employers under final paragraph (c)(1)(iv) is likely to contain proprietary information or trade secrets. OSHA recognizes, however, that an unusual case could arise presenting issues related to trade secrets. In any such case, OSHA expects that the host employer will find a way to provide the necessary information to the contract employer without divulging trade secrets or will share the information with the contract employer pursuant to an appropriate confidentiality agreement.

Southern Company expressed concern that contractors and their employees might rely on the information provided by the utility in lieu of doing a thorough job briefing as required by final § 1926.952 (Ex. 0212). Final § 1926.950(c)(1)(i), which requires host employers to provide information to contractors, does not replace the contract employer's basic responsibility to conduct the job briefing required by final § 1926.952. The briefing will impart information, including relevant information a contractor obtains from a host employer, to the employees doing the work. The requirements in final §§ 1926.950(c)(1) and (d) and 1926.952 work in combination to ensure that the employees performing the work are provided with sufficient information to perform that work safely.

Proposed paragraph (c)(1)(i)(B) required host employers to provide contract employers with information about the installation that the contract employer would need to make the assessments required elsewhere in Subpart V. EEI inquired as to who (the host or contract employer) would be responsible for deciding what assessments the contractor must make and whether the host would have to survey contractor work areas to identify hazards that need assessment (Ex. 0227).

The language in final paragraph (c)(1)(iii) states explicitly that, before work begins, the host employer must provide information that the *contract employer* needs to perform the assessments. In addition, the language from the proposal has been modified in the final rule to limit the information the host employer must provide to "[i]nformation about the design and operation of the host employer's installation." Table 2 shows the assessments that are implicitly or explicitly required by final subpart V and lists information that the Agency anticipates contractors will need to perform the required assessments.

TABLE 2—ASSESSMENTS REQUIRED BY SUBPART V

Provision	Assessment required	Type of information to be provided under § 1926.950(c)(1)(iii)
§ 1926.953(a)	Whether an enclosed space must be entered as a permit-required confined space.	Whether an enclosed space contains hazards, other than electrical and atmospheric hazards, that could endanger the life of an entrant or could interfere with escape from the space.
§ 1926.953(m)	Whether forced air ventilation has been maintained long enough that a safe atmosphere exists.	The size of the enclosed space.
§ 1926.960(c)(1)(i)	What is the appropriate minimum approach distance for the work to be performed.	What the operating conditions are for the value of the maximum transient overvoltage provided to the contract employer.[1]
§ 1926.960(g)(1)	Whether employees are exposed to hazards from flames or electric arcs.	Information on electric equipment, such as safety information provided by manufacturers, that relates to the required hazard assessment.
§ 1926.960(g)(2)	What is the estimated incident energy from an electric arc.	The electrical parameters needed to calculate incident energy, such as maximum fault current, bus spacings, and clearing times.
§ 1926.960(k)	Whether devices are designed to open or close circuits under load conditions.	Load current for, and the opening and closing ratings of, devices used to open and close circuits under load.
§§ 1926.961 and 1926.967(h).	What are the known sources of electric energy (including known sources of backfeed) supplying electric circuits.	All known sources of electric energy, including known sources of backfeed.
§ 1926.962(d)(1)(i)	Whether protective grounds have adequate current-carrying capacity.	The maximum fault current and clearing time for the circuit.
§ 1926.962(g)	Whether there is a possibility of hazardous transfer of potential should a fault occur.	Potential rise on remote grounds under fault conditions.
§ 1926.964(a)(2)	Whether overhead structures such as poles and towers are capable of sustaining stresses imposed by the work.	The design strength of the pole or structure.

[1] Includes information on conditions that must be in place for the maximum transient overvoltage to be valid, such as whether circuit reclosing devices are disabled.

In specific cases, contractors may need information that is somewhat different from that described in Table 2. OSHA expects that contractors will inform host employers if they need additional information, and that information must be provided to the extent the host employer is required to provide it by final paragraph (c)(1)(iii). In addition, the Agency does not expect host employers to provide contractors with information in the table if the contractor informs the host that the information is not needed.

EEI questioned whether the proposed provision was limited to information actually known by the host employer (Ex. 0227). OSHA expects that the host employer will usually have, in existing records, information about the design and operation of its installation that the contract employer will need to make required assessments. OSHA presumes that host employers know their electric power generation, transmission, or distribution installations and know their systems' nominal system and operating voltages, available fault currents, relay protection schemes, anticipated relay clearing times, and switching schedules. As IBEW noted, this is information "that the host employer should have for basic operational purposes and that is

generally solely in the host's possession" (Ex. 0505). In addition, electric utilities will also need to have this information to perform their own required assessments when their employees are performing work on the utilities' installations. However, the record also indicates that, in some unusual circumstances, electric utilities do not have basic information about their system readily available. (See Mr. Brian Erga's testimony regarding a nuclear power plant that did not know its available fault current, Tr. 1241–1242.) In such cases, the final rule requires the host employer to ascertain the information and provide it to its contractor so that the contractor can conduct the required assessments. A note to final paragraph (c)(1)(iii) clarifies that, in any situation in which the host does not have such information in existing records, it must obtain the information and provide it to the contract employer to comply with paragraph (c)(1)(iii).[70]

Mr. Steven Theis of MYR Group recommended that the final rule require hosts and contractors to perform joint hazard analyses (Tr. 1334).

The final rule neither requires nor prohibits such joint assessments. Even if employers do not conduct a joint hazard analysis, the information exchange required by final paragraph (c)(1) of the final rule will be part of a two-way conversation between host employers and contract employers. As discussed later in this section of the preamble, final paragraph (c)(3) requires hosts and contractors to coordinate their work rules and procedures to ensure that employees are protected as required by subpart V. To comply with the final rule, the contractor, as part of this effort, must communicate with the host about the information the contractor needs about the host's installation.

OSHA notes that final paragraph (c)(1) does not require the host employer to report any information to the contract employer in writing; the Agency will deem it sufficient for the host employer to provide the necessary information, through any appropriate mechanism (for example, a phone call or an email), to an authorized agent of the contractor.

[70] The preamble to the proposal indicated that proposed paragraph (c)(1)(i) would not require host employers to provide "unknown information" to contractors (70 FR 34840). It should be noted, however, that OSHA presumes that host employers "know" the information that must be shared under final paragraphs (c)(1)(i) and (c)(1)(iii) because it relates to the design and operation of the installation, which are aspects of an electric power generation, transmission, or distribution system that are under the exclusive purview of the host employer.

Proposed paragraph (c)(1)(ii) would have required the host employer to report observed contract-employer-related violations of subpart V to contract employers. OSHA included this provision in the proposal because the Agency believed that host employers occasionally observe contractor employees performing work under the contract and that it was important for the host employer to inform the contract employer of observed violations so that the contractor could correct them and prevent them from occurring in the future.

OSHA received many comments on this proposed requirement. (See, for example, Exs. 0128, 0152, 0160, 0167, 0169, 0170, 0171, 0178, 0183, 0186, 0201, 0222, 0227, 0235, 0505; Tr. 880–882.) IBEW supported the need for a reporting requirement, explaining:

> [T]he point is that if in performing its usual functions the host observes contract employees exposed to hazards, it must report those observations to their contract employer. This requirement is particularly important in the electrical industry where contract employees are potentially exposed to extremely serious hazards.
>
> If the host employer who knows the worksite's hazards and the potential for harm sees a contract employee exposed to those conditions the host knows to be hazardous, it is unconscionable for the host to walk away. The host must report that information to the contract employer so the contract employer can take the steps necessary to eliminate the unsafe condition, and the contract employer must report back what action it actually took . . . [Tr. 881].

Many commenters objected to the proposed reporting requirement, however. (See, for example, Exs. 0128, 0152, 0167, 0170, 0178, 0183, 0186, 0222, 0227.) Some expressed concerns about putting host employers in an enforcement role and requiring them to make determinations about whether an OSHA violation exists. (See, for example, Exs. 0128, 0152, 0170, 0178, 0183, 0222, 0227.) For instance, EEI commented:

> The proposal would require a host employer to report observed contract-employer-related *violations of the standard* to the contract employer.
>
> * * * * *
>
> Typically, utility employees and managers are not trained "in the requirements of" OSHA standards." [*sic*] Rather . . . they are trained in the requirements of their own employer's safety rules. . . . There simply are no requirements that any employee know what OSHA standards require—only that behavior and work practices be in compliance with standards. Employees are entitled, however, to assume that if they comply with their employer's safety rules, they will comply with OSHA standards. . . . Indeed, among EEI members, the requirements of safety rules often exceed the minimum requirements of OSHA standards.
>
> Clearly, the proposed requirement would create confusion. Utility representatives may believe they are seeing OSHA violations, but in fact may observe that contractors are not performing as the utility's internal safety rules require. [T]he proposal would effectively place utility personnel in the role of surrogate Compliance Officers. They are not trained or qualified to perform such a function. [Ex. 0227; emphasis included in original]

Mr. Alan Blackmon with the Blue Ridge Electric Cooperative suggested that, "[b]y requiring the [host] employer to report on the violation of a federal rule, the proposal in a sense deputizes the employer as an OSHA inspector, a role for which employers have no training and no experience" (Ex. 0183). Mr. Chris Tampio of the National Association of Manufacturers argued that, by requiring hosts to report observed violations, OSHA "would inappropriately force a host employer to make a legal determination as to whether the contractor has committed a violation of the OSH Act" (Ex. 0222).

EEI was also concerned that host employers would be cited for failing to report violations that were present, but not recognized by, the host's employees, commenting:

> The proposal provides no guidance as to the kinds of observation that would trigger a notification requirement. For example, [utilities commonly] engage inspectors . . . to observe contractors' performance. In other situations, this is performed by a utility's own foremen or supervisors. Such inspections often are aimed at assuring that the work is performed accurately and in timely fashion, and observation of safety performance, while important, may not be the main or only focus. If a utility inspector is found to have had the opportunity to observe a contractor's violative behavior but did not understand or appreciate what he saw and failed to report it, would the host be cited? [Ex. 0227]

Similarly, Duke Energy commented: "Host employers may have a variety of employees observing contract operations for reasons unrelated to safety. They may be observing contract operations for quality, schedule, productivity, or cost purposes. A host employee may 'observe' a condition, but not recognize it as a violation of this OSHA regulation" (Ex. 0201).

Some commenters presumed that the proposal required host employers to either actively monitor contractors or take measures to ensure that reported hazards were abated. (See, for example, Exs. 0187, 0225, 0235, 0238, 0504.) For instance, Mr. James Strange with American Public Power Association (APPA) commented that municipal

utilities "do not have the personnel to shadow contractors on each utility job site to assure that they are working according to OSHA rules" (Ex. 0238). In addition, several commenters argued that the proposal would create an adversarial relationship between hosts and contractors. (See, for example, Exs. 0169, 0171, 0183.) Mr. Wilson Yancey expressed this argument as follows:

> [T]he proposed requirements might create an unduly adversarial relationship between the parties. For instance, the host employer seeking to fulfill its perceived duties under the regulations would thrust the host employer into the role of an investigator and rule-enforcer, rather than a business partner seeking to achieve a common goal of employee safety. [Ex. 0169]

After considering the comments received on this issue, OSHA decided not to include proposed paragraph (c)(1)(ii) in the final rule. First, the host employer, as defined in the final rule, may not be in position to recognize, or even observe, hazardous conditions created by contract employers. OSHA based the proposed rule on the premise that the host employer would hire the contract employer and would perform some maintenance on the system. As noted earlier, in the final rule, the Agency adopted a definition of "host employer" that is designed to capture the employer in the best position to provide information about the electric power generation, transmission, or distribution installation on which the contract employer is working. The definition of "host employer" in the final rule does not require the host employer to maintain the installation or to be the entity that hired the contractor. A host employer that does not perform maintenance work on the system would be unlikely to recognize hazardous conditions created by contractors. In addition, a host employer that does not hire the contract employer usually would not find itself in a position to observe the contractor's employees working.[71]

Second, in some circumstances, the host employer will also be a controlling employer under OSHA's multiemployer citation policy. A controlling employer has an underlying duty to exercise reasonable care to prevent and detect violations endangering contractor employees at the worksite. (See CPL 02–00–124; see also OSHA's discussion of the multiemployer citation policy earlier in this section of the preamble.) This is a broader obligation than the one OSHA proposed for host employers in proposed paragraph (c)(1)(ii); therefore, the proposed requirement is not necessary with respect to hosts that are controlling employers. (Whether a host employer is a controlling employer depends on whether it has general supervisory authority over the worksite, including the power to correct, or require others to correct, safety and health violations.[72]) Indeed, the Agency is concerned that including the proposed reporting requirement in the final rule would lead host employers to believe they could fulfill their obligations as controlling employers just by complying with the more limited requirement in the standard.

Although OSHA is not including proposed paragraph (c)(1)(ii) in the final rule, the Agency expects that, in many situations, liability and practical considerations will drive host employers that are not controlling employers to notify the contractor if they observe hazardous conditions involving the contractor's employees. Unsafe conditions created by contractors can pose hazards to employees of the host employer and to the public and can create additional obligations for host employers to protect their employees (for example, through OSHA standards and the general duty clause) and the public (for example, through liability concerns) from those hazards. For instance, a host employer that observes a contractor bypassing safety rules when installing a new line will likely have concerns about the quality of the contractor's work and about the effect of the contractor's unsafe practices on the installation and on public safety. These concerns will form a strong incentive for the host employer to report the hazardous conditions to the contractor.

Although the Agency concluded, based on the current rulemaking record, that the reporting requirement in proposed paragraph (c)(1)(ii) is neither necessary nor appropriate for this final rule, the Agency will continue to monitor this issue and evaluate whether regulatory requirements like the one in proposed paragraph (c)(1)(ii) are necessary to ensure the safety of employees under subpart V or other OSHA standards.

Proposed paragraph (c)(2)(iii)(C) would have required the contract employer to advise the host employer of measures taken to correct, and prevent from recurring, violations reported by the host employer under proposed paragraph (c)(1)(ii). In light of the Agency's decision not to adopt proposed paragraph (c)(1)(ii), proposed paragraph (c)(2)(iii)(C) is no longer meaningful and is not incorporated in the final rule.

In addition to proposing the requirement for hosts to report observed contract-employer-related violations, OSHA requested comments on the related, but distinct, issue of whether it should require host employers to take appropriate measures to enforce contractual safety requirements or review the contracts of contractors who fail to correct violations.[73]

IBEW was the only commenter that supported such requirements, explaining:

> The host employer should regularly review the safety performance of a contractor while operating on its site. The host employer should take necessary action to ensure contractual obligations are being met. The rule should require the host employer to initiate further action if the review finds non compliance. [Ex. 0230]

Rulemaking participants agreed that host employers regularly adopt contracts that specify safety standards to which contractors must adhere and that include provisions for enforcing those requirements. (See, for example, Exs. 0163, 0175, 0213, 0405; Tr. 1386–1387.) Also, some commenters recognized a general need for hosts to evaluate the safety performance of contractors. (See, for example, Exs. 0167, 0175, 0184, 0213, 0219.) However, none of these rulemaking participants supported the adoption of OSHA requirements related to the enforcement, review, or awarding of contracts.

For example, Ms. Susan O'Connor with Siemens Power Generation explained:

> While host employers often [require and enforce compliance with OSHA standards], in practice it would be burdensome [on] the host employer to require them, at the risk of OSHA sanctions, to enforce contract provisions as a regulatory matter. Indeed, establishing this as a regulatory standard could operate as a disincentive for host employers to establish sound health and safety contractual terms with contractors,

[71] For example, a generation plant owner could contract with a company to operate, but not maintain, the plant. If the plant owner neither operates nor controls operating procedures for the installation, the company it contracts with to operate the plant is the host employer under the final rule. The plant owner could hire a different company to perform maintenance in the substation in the generation plant. Because the host employer in this scenario does not perform maintenance, it is likely that the host employer will not have any employees qualified to enter the substation, and, thus, will not observe the maintenance contractor's employees.

[72] Such control can be established by contract or by the exercise of control in practice.

[73] Contracts between electric utilities and their contractors often contain provisions requiring contractors to meet OSHA standards and other provisions addressing noncompliance with the terms of the contract. (See, for example, Ex. 0175.)

particularly terms which go beyond regulatory requirements. . . . In addition, OSHA regulations are promulgated and undergo public review; Host Employer requirements do not go through such a regulatory review process and therefore must not be held on par with OSHA regulations. Host employers have a right to establish site safety requirements that are more stringent than the law requires; however, they should have the right to deal with contractors who do not comply individually and in their own manner. But they must currently do this against the backdrop of specific OSHA standards, and the OSHA Multi-employer Workplace policy. Siemens sees no reason to change this.

* * * * *

OSHA should not prescribe how contractors are selected or prescribe how contractors must be evaluated for purposes of contracting work or terminating work. It is up to the discretion of the party contracting for the services to make those determinations. Host employers should have the discretion to choose, to dismiss, or continue utilizing contractors. Given the already comprehensive and pervasive nature of health and safety regulation through OSHA and the states, as well as considerations of tort law, the effects of the marketplace will weed out contractors that are repeatedly substandard from a safety standpoint, as well as those that are chronically poor perform[ers] from a quality, delivery, or other standpoint. Contractors should be answerable to the host employe[r] for business matters, and the agency for regulatory matters. These lines should not be blurred by attempting to make the host employer responsible for both. As a practical matter, it would be impossible for OSHA . . . to come up with minimum requirements for every contract activity, to establish an "acceptable" versus "unacceptable" contractor. [Ex. 0163]

Duke Energy commented:

The only safety performance that OSHA has authority to regulate is compliance with OSHA rules. Worker Compensation Insurance Carriers and others review safety performance. There is no need for OSHA to impose additional requirements. Each host employer is faced with a unique set of available contractors, each with its own safety record. Some may excel in one area and perform poorly in another. Some host employers may have such a limited pool of available contractors that requiring some pre-determined level of contractor safety performance would eliminate all contractors. Other goals, such as employing minority firms may cause hosts to work with poor performers to improve their performance, rather than eliminating the minority contractor with the poor record. OSHA should not interfere in decisions such as these. [Ex. 0201]

In light of the comments received, OSHA decided not to adopt provisions requiring host employers to enforce contractual safety requirements, to review the contracts of contractors who fail to correct violations or hazards, or to evaluate the safety performance of contractors. As discussed previously, the host employer might not be the entity that hired the contract employer, in which case the host employer would not be in position to enforce contract requirements or be involved in awarding contracts to the contract employer. In addition, as Ms. O'Connor pointed out, and as noted earlier in this section of the preamble, host employers that have supervisory authority over a contractor's worksite are subject to a background statutory obligation, as set forth in OSHA's multiemployer citation policy, to exercise reasonable care to detect and prevent violations affecting contractor employees. Moreover, for the reasons stated previously, OSHA believes that, even in the absence of a specific requirement in subpart V, host employers that are not controlling employers have strong incentives to take measures to ensure safe contractor performance. In addition, the Agency believes that contractors with poor safety performance are likely to have similarly poor records with respect to the quality of their work, making it less likely that host employers will hire them. Therefore, the final rule does not contain provisions related to the enforcement, review, or awarding of contracts.

Paragraph (c)(2) of final § 1926.950 addresses the responsibilities of the contract employer. Final paragraph (c)(2)(i) requires the contract employer to ensure that each of its employees is instructed in any hazardous conditions relevant to the employee's work of which the contractor is aware as a result of information communicated to the contractor by the host employer as required by final paragraph (c)(1). This paragraph ensures that information on hazards the employees might face is conveyed to those employees. The information provided by the host employer under paragraph (c)(1) is essential to the safety of employees performing the work, especially because it may include information related to hazardous conditions that the contract employees might not identify or recognize.

Proposed paragraph (c)(2)(i) was worded differently from the final rule; the proposed paragraph required contractors to instruct their employees in hazards communicated by the host employer. OSHA received no comments on this proposed provision. However, changes were made to this paragraph in the final rule to mirror the changes made to paragraph (c)(1) (described earlier). In the final rule, the Agency did not include the note to proposed paragraph (c)(2)(i) because OSHA believes that the note was confusing. The proposed note suggested that the instruction required under paragraph (c)(2)(i) was not part of the training required under § 1926.950(b). The contractors' employees will already be trained in many of the hazards that are related to the information the contractor receives from the host, and the final rule does not require employers to duplicate this training. Contractors will need to supplement an employee's training only when that employee will be exposed to a hazard or will follow safety-related work practices with respect to which he or she has not already been trained.

Paragraph (c)(2)(ii), as proposed, required the contract employer to ensure that its employees followed the work practices required by subpart V, as well as safety-related work rules imposed by the host employer. In proposing this provision, OSHA explained that a host employer's safety-related work rules are almost certain to impact the safety and health of the contractor's employees (70 FR 34840). For example, electric utilities typically require contractors to follow the utilities' procedures for deenergizing electric circuits. If the contract employer's employees do not follow these procedures, a circuit the contractor's employees are working on might not be properly deenergized, endangering the contractor's employees, or a circuit the contractor was not working on might become reenergized, endangering any host employer's employees that might be working on that circuit.

OSHA invited comments on whether requiring a contractor to follow a host employer's safety-related work rules could make work more hazardous. A few commenters supported proposed paragraph (c)(2)(ii). (See, for example, Exs. 0164, 0213.) For instance, Mr. Tommy Lucas of TVA commented:

The proposed requirement is supported. Regardless whether this requirement is carried forward, we will require contractors to follow certain host-employer safety rules contractually, such as the lockout/tagout (LOTO) procedure. Failure to follow the LOTO procedure could result in host or contractor employees being seriously injured. [Ex. 0213]

In contrast, the vast majority of rulemaking participants opposed the proposed provision. (See, for example, Exs. 0156, 0161, 0162, 0168, 0183, 0201, 0202, 0212, 0220, 0222, 0227, 0233, 0237, 0501; Tr. 1323, 1333.) These commenters gave several reasons for objecting to this proposed requirement:

- It could result in the implementation of inadequately safe work rules, such as when the contractor has more protective work rules than the

host (see, for example, Ex. 0161) or when the host's work rules may be based on its own employees' working conditions that are less hazardous than the working conditions to which contractor employees will be exposed (see, for example, Ex. 0233).

- It could cause contract employees to be confused about proper work methods if rules change from contract to contract (see, for example, Ex. 0227).
- It would result in contractual requirements becoming enforceable OSHA standards in a way that constitutes an illegal delegation of OSHA's rulemaking authority, thereby circumventing proper rulemaking procedures (see, for example, Ex. 0237).
- It would place OSHA in the position of having to interpret and enforce third-party contracts (see, for example, Ex. 0233).
- It could increase disaster-response time (Ex. 0233).
- It would increase costs and administrative burdens on contract employers (see, for example, Ex. 0162).
- It could result in contractors having to follow host employer work rules that are not directly linked to employee safety, for example, in a situation in which the host's rules approve only one vendor for safety equipment when equivalent, equally protective, equipment is available from other vendors (Ex. 0162).

For instance, Mr. Steven Theis with MYR Group commented:

> MYR Group believes that requiring a contractor to follow a host's safety rules would create hazards. Contractors are required by the standard to have appropriate work rules and policies for compliance. Requiring them to follow another employer's policies—which they are unfamiliar with and untrained on—would either result in accidents or add undue and unnecessary time for retraining and familiarization with the policies when the contractor has its own policy . . . Indeed, MYR Group has experienced situations where host employers impose work rules that do not significantly affect employee safety and may even create an unsafe situation. [H]ost work rules can specify chain of command requirements that do not align with contractor management structure or responsibility and thus following host requirements could result in loss or miscommunication of safety information or safe work directives. Accordingly, MYR Group respectfully submits that the requirement to follow host employer work rules should be deleted. [Ex. 0162]

Mr. Terry Williams with the Electric Cooperatives of South Carolina agreed and provided an example of how following a host employer's safety rules could jeopardize worker safety:

> The proposal ignores the fact that contractors have developed their own rules that are appropriate for the work they do. They train on these rules and operate according to them all the time. Requiring contractors . . . to work to the rules of others could easily result in the contractor working less safely.
>
> Consider the following actual situation: an electric utility that is primarily a 12kV system, with some 34.5kV. The utility uses its own crews for the 12kV work, and uses a qualified contractor for the 34.5kV work, as the need arises. The utility's safety rules specify use of Class 2 gloves, sleeves and cover up for all work, as that is all their line crews need. For the 34.5 kV work, the contractor should use Class 4 equipment, yet OSHA's proposal could justify use of Class 2, with unsafe results.
>
> OSHA should retract this proposal and allow host employers to require contractors to work to appropriate safety rules. [Ex. 0202]

EEI made similar comments in its posthearing brief:

> [T]he standard would require contractors to utilize different safe procedures depending upon the owner involved. For example, an electric line contractor could be required to observe a "ground-to-ground" rubber glove requirement while working for one electric utility, but not while working for another utility nearby (Tr. 110–11). The confusion and consequent increased risk to employees from such requirements is obvious, not to mention the cost of training for employees and supervisors alike. [Ex. 0501]

As to the legal arguments, Susan Howe with the Society of the Plastics Industry suggested that "OSHA's incorporation" of the host employer's rules "into the OSHA standards which are the subject of this rulemaking would violate the rulemaking provisions of the Occupational Safety and Health Act, the Administrative Procedures Act, and the Federal Register Act" (Ex. 0170). The National Association of Manufacturers similarly stated, with reference to this provision: "OSHA has never had the authority to incorporate the provisions of millions of private contracts into OSHA standards, nor to delegate its rulemaking authority to private entities" (Ex. 0222). EEI also commented that the proposed requirement "effectively would place each host employer in the position of promulgating safety and health standards for contractors' employees, and therefore would constitute an unconstitutional delegation of legislative power" (Ex. 0227).

OSHA does not believe that the proposed provision would cause the practical problems identified by rulemaking participants. There is evidence in the record that, as IBEW stated, "contractors . . . routinely adapt their work rules and safety practices to accommodate the demands of particular jobs and the requirements of specific hosts" (Ex. 0505). The union explained this statement as follows:

> There are circumstances related to contractors performing work on utility properties that would require the contractors to work under the host employer's safety related work rules to ensure both the contractor employees and the host employer employees are provided a safe work environment. In fact, many collective bargaining agreements require this. [Ex. 0230]

Mr. Brian Erga with ESCI noted that some utilities have such unique systems that contractors have no choice but to follow the host's rules (Tr. 1271–1272). Several witnesses stated that contractors routinely follow a host employer's lockout-tagout requirements (Tr. 314, 984, 1299–1301). There is evidence that some host employers require contractors to follow NFPA 70E (Ex. 0460), to follow the host's fall protection requirement for working from aerial lifts (Tr. 391), and to use particular types of flame-resistant clothing (Tr. 1346). In addition, the proposal did not require contractors to follow all of the host employer's safety rules, only rules the host imposes on contractors, which the contractors are required to follow anyway. The Agency also does not believe that proposed paragraph (c)(2)(ii) would result in undue confusion from work rules that vary from one employer to another. The record indicates that contractors are already required to institute different work rules because of contractual or other requirements imposed by host employers, such as following the host employers' lockout-tagout procedures (Tr. 314), using particular live-line work methods (Tr. 320), and using particular forms of fall protection (Tr. 643–644).

On the other hand, the record establishes that hosts sometimes impose rules that do not meet OSHA requirements (Tr. 1366[74]) or that may be less safe than the contractor's rules (Tr. 1365–1366[75]). These are outcomes that OSHA did not envision in proposing paragraph (c)(2)(ii). Considering these potential risks, and the commenters' overwhelming opposition to this proposed provision, the Agency decided not to include proposed paragraph (c)(2)(ii) in the final rule.

OSHA concludes, however, that some coordination of work rules between

[74] Some host employers "don't believe in equipotential work zone," which is required by existing § 1910.269(n)(3), or want trucks barricaded, instead of having them grounded, as required by existing § 1910.269(p)(4)(iii)(C).

[75] One host employer requires contractor employees to wear rubber insulating gloves while working with live-line tools on transmission lines, which may cause the gloves to fail.

hosts and contractors is necessary, particularly with respect to deenergizing lines and equipment (Ex. 0505) and grounding procedures (Tr. 1271–1272). According to IBEW:

> [What is important] is not that one party's rules take precedence over the others. Instead, what is important is that the parties operating on an electrical system coordinate procedures to ensure that all of the employees can perform safely. There are two sets of circumstances in which this kind of coordination is an issue: Where employees actually work together and when the manner in which one group of employees performs has an impact on the safety of another group of employees. [Ex. 0505]

Other rulemaking participants similarly supported a requirement for coordination between host employers and contract employers to assure the protection of host employees and contract employees. (See, for example, Exs. 0128, 0235, 0237.) Therefore, the Agency is adopting a new paragraph in the final rule, § 1926.950(c)(3), entitled "Joint host- and contract-employer responsibilities," which reads as follows:

> 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.

This new provision provides host employers and contract employers more flexibility than the proposal to select appropriate work rules and procedures for each task or project, while ensuring that workers are not at risk of harm due to a lack of coordination between employers.

Under the new provision, each employer has independent responsibility for complying with the final rule. In addition, the Agency stresses that a contract employer must comply with the final rule even though a host employer may try to impose work rules that would cause the contract employer to violate OSHA's rules. Accordingly, a contract employer is not relieved of its duty to comply with the final rule by following a work rule imposed by the host employer. For example, a contract employer must comply with final § 1926.962(c), which prescribes rules for equipotential grounding, even if the host employer has its own noncompliant grounding procedures. Paragraph (c)(3) of final § 1926.950 requires host employers and contract employers to confer in an effort to select work rules and procedures that comply with final § 1926.962(c).

Final paragraphs (c)(2)(ii) and (c)(2)(iii) (proposed as part of paragraph (c)(2)(iii)) require the contract employer to advise the host employer of unique hazardous conditions posed by the contract employer's work [76] and any unanticipated hazardous conditions found, while the contractor's employees were working, that the host employer did not mention. Final paragraphs (c)(2)(ii) and (c)(2)(iii) enable the host employer to take necessary measures to protect its employees from hazards of which the host employer would not be aware. These requirements will protect the host employer's employees: when they are working near the contractor's employees (for example, during storm situations (Tr. 315, 392, 1379–1380); during outages on transmission lines (Tr. 1380) and in plants (Tr. 985); while working in the same substation (Tr. 313–314, 559); and when the host employer's employees work on the same equipment after the contract employer departs (such as, when contractors are working on equipment in the field that the host employer does not regularly inspect) (Tr. 877–878)). The Utility Workers Union supported these proposed requirements, commenting: "Requiring the sharing of information of hazards found or created by the contractor is . . . insurance that all employees, host and contractor, are in a safer working environment" (Ex. 0197). OSHA notes that proposed paragraph (c)(2)(iii)(B) (now paragraph (c)(2)(iii)) required contractors to report any unanticipated "hazards" not mentioned by the host; however, in the final rule, the phrase "hazardous conditions" replaces the word "hazards" throughout paragraph (c). In addition, the Agency anticipates that contract employers will inform host employers of any information provided by the host that is at odds with actual conditions at the worksite, consistent with paragraph (c)(3), which specifies that host employers and contract employers coordinate their work rules and procedures so that each employee is protected as required by subpart V.

Some commenters believed that proposed paragraph (c)(2)(iii) (now paragraphs (c)(2)(ii) and (c)(2)(iii)) needed clarification. For example, the Associated General Contractors of America (AGC) commented that proposed paragraph (c)(2)(iii) was vague and did not provide guidance on the timeframes or format of required information transfers (Ex. 0160).

OSHA does not agree that final paragraphs (c)(2)(ii) or (c)(2)(iii) are vague or unclear. These provisions simply require that contractors provide information to host employers, which reciprocates the requirements under final paragraph (c)(1) that host employers provide contractors with information. The Agency deliberately omitted, in the proposed and final rules, any requirement for a formal or written report; the final rule simply requires contractors to advise the host employer, which allows contract employers maximum flexibility in complying with the final requirements. The Agency will deem it sufficient for the contract employer to provide the necessary information, through any appropriate mechanism (for example, a phone call or an email), to an authorized agent of the host employer.

The purpose of final paragraph (c)(2)(ii) is to enable host employers to protect their own employees from hazardous conditions presented by the contractor's work. Thus, the information addressed by paragraph (c)(2)(ii) needs to be provided to the host employer soon enough so that the host employer can take any necessary action before its employees are exposed to a hazardous condition. To address AGC's concern that the proposed paragraph did not provide guidance on the timeframe of the required information transfer, OSHA added language to paragraph (c)(2)(ii) in the final rule to indicate that this information must be provided "[b]efore work begins."

The final rule also includes, in paragraph (c)(2)(iii), a 2-working day timeframe in which the contractor must advise the host employer of information described in that paragraph. OSHA believes that this timeframe will give the contract employer sufficient time to provide the required information. The final rule does not specifically require hosts to take any direct action in response to information provided by contractors, although the Agency anticipates that host employers will use this information to protect their employees and comply with the OSH Act.

Frequently, the conditions present at a jobsite can expose workers to unexpected hazards. For example, the grounding system available at an outdoor site may be damaged by weather or vehicular traffic, or communications cables in the vicinity could reduce the approach distance to an unacceptable level. To protect employees from such adverse situations, conditions affecting safety that are present in the work area should be known so that appropriate action can be taken. Paragraph (d) of § 1926.950 addresses this problem by requiring safety-related characteristics and conditions existing in the work area to

[76] For the purposes of final paragraph (c)(2)(ii), "unique hazardous conditions presented by the contract employer's work" means hazardous conditions that the work poses to which employees at the worksite are not already exposed.

be determined before employees start working in the area. The language for proposed paragraph (d) was based on language in current § 1926.950(b)(1) and was the same as existing § 1910.269(a)(3). A similar requirement can be found in ANSI/IEEE C2–2002, Rule 420D.[77] As noted earlier, OSHA revised the language in the final rule to clarify that the paragraph addresses installation characteristics, as well as work-area conditions, and to separately number the examples listed in the provision.

OSHA received only a few of comments on proposed paragraph (d). EEI objected to this provision, commenting:

> EEI recognizes that the regulatory text of proposed paragraph 1926.950(d) is the same as in existing 1910.269(a)(3). Also, the preamble accompanying the current proposal is essentially the same as in the final 1910.269. There are certain aspects of the current proposal, however, that are troublesome. . . .
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> * * * * *
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> It is susceptible of being applied in a manner that effectively requires an employer to examine every imaginable condition on a jobsite, lest it be held accountable if some obscure, unexpected condition later is involved in causing an accident.
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> * * * * *
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> [I]f the standard is not applied reasonably, the result could be a significant burden for line crews, as time is taken not to miss a single detail, however obscure, lest the crew be second-guessed for having missed observing some condition if something later goes wrong. In the final rule, OSHA needs to address this issue. Rather than state that there is an unqualified obligation to "determine" existing conditions relating to the safety of the work, the obligation should be modified to require a "reasonable effort to determine" the reasonably anticipated hazards. [Ex. 0227]

EEI noted, as an example of "some obscure, unexpected condition . . . involved in causing an accident," an energized static line that caused the electrocution of an apprentice line worker (*id.*):

> In that case, the contractor was performing maintenance work on a high-voltage transmission tower. The host utility was shown to have been aware that what appeared to be a grounded static line atop one side of the tower was in fact energized at 4,000 volts. The utility did not inform the contractor of this information, however, and the contractor's foremen on the ground and on the tower did not notice that there was an insulator separating the line and tower, thus indicating that the line could be energized. [*Id.*]

EEI stated that the contractor was cited, under existing § 1910.269(a)(3), "for failing to ascertain existing conditions, *i.e.*, the energized condition of the static line, before beginning work" (*id.*).

OSHA considered this comment and decided not to adopt EEI's recommended change to proposed § 1926.950(d). First, OSHA does not believe that obscure and unexpected conditions often lead to accidents, as EEI seems to argue. EEI's example, in which an apprentice power line worker was electrocuted by an energized static line, is a case in point (*id.*). An employer exercising reasonable diligence can be expected to determine that a static line is energized. In the case described by EEI, the electric utility that owned the line was aware that the line was energized, and the line itself was installed on insulators (*id.*). Thus, the energized condition of the static wire was neither obscure nor unexpected.

Second, EEI appears confused about the purpose of this provision. Paragraph (d) of final § 1926.950 requires employers to determine, before work is started on or near electric lines or equipment, existing installation characteristics and work-area conditions related to the safety of the work to be performed. The requirement also includes examples of such characteristics and conditions.

Characteristics of the installation, such as the nominal voltage on lines, maximum switching transient overvoltages, and the presence of grounds and equipment grounding conductors, are parameters of the system. This is information the employer already has, either through direct knowledge or by the transfer of information from the host employer to the contract employer.[78] Thus, this aspect of final paragraph (d) does not place any burden, much less an unreasonable one, on line crews.

Conditions of the installation, including the condition of protective grounds and equipment grounding conductors, the condition of poles, and environmental conditions relating to safety, are worksite conditions. In some cases, the employer already will have information on the condition of the installation, such as information on the condition of poles from pole-inspection programs or on the condition of electric equipment from equipment manufacturers. In the usual case, however, the conditions addressed by paragraph (d) of the final rule will be determined by employees through an inspection at the worksite. This inspection need not be overly detailed, but it does need to be thorough rather than cursory. The standard does not require crews to determine "every imaginable condition," as EEI suggests. Rather, the inspection must be designed to uncover the conditions specifically noted in this paragraph as well as any other conditions of electric lines and equipment that are related to the safety of the work to be performed and that can be discovered through the exercise of reasonable diligence by employees with the training required by § 1926.950(b) of the final rule.

Employers are required by § 1926.952(a)(1) of the final rule to provide information on such worksite-specific conditions and the characteristics of the installation to the employee-in-charge. With this information, the employer then will determine the current conditions of the installation through an examination by employees at the worksite. Employer-supplied information, as well as information gathered at the worksite, must be used in the job briefing required by § 1926.952 of the final rule. (See the discussion of § 1926.952 later in this section of the preamble.) The characteristics and conditions found as a result of compliance with final § 1926.950(d) could affect the application of various Subpart V requirements. For example, the voltage on equipment will determine the minimum approach distances required under final § 1926.960(c)(1). Similarly, the presence or absence of an equipment grounding conductor will affect the work practices required under final § 1926.960(j). If conditions are found to which no specific subpart V provision applies, then the employee would need to be trained, as required by final § 1926.950(b)(1)(ii), to use appropriate safe work practices.

Employers need not take measurements on a routine basis to make the determinations required by final § 1926.950(d). For example, knowledge of the maximum transient voltage level is necessary to perform many routine transmission and distribution line jobs safely. However, no measurement of this maximum level is necessary to make the requisite determination. Employers can make the determination by conducting an analysis of the electric circuit, or they can assume the default maximum transient overvoltages discussed under the summary and explanation of final § 1926.960(c)(1), later in this section of

[77] The 2012 NESC contains an equivalent requirement in Rule 420D.

[78] The employer may not have knowledge of the exact locations of customer-owned backup generators; however, the location of possible sources of backfeed from such customer-owned equipment can readily be determined by looking for connections to customers' wiring in circuit diagrams or during an inspection at the worksite.

the preamble. Similarly, employers can make determinations about the presence of hazardous induced voltages, as well as the presence and condition of grounds, without taking measurements.

It may be necessary for employers to make measurements when there is doubt about the condition of a ground or the level of induced or transient voltage if the employer is relying on one of these conditions to meet other requirements in the standard. For example, an engineering analysis of a particular installation might demonstrate that the voltage induced on a deenergized line is considerable, but should not be dangerous. However, a measurement of the voltage may be required if the employer is using this analysis as a basis for claiming that the provisions of final § 1926.964(b)(4) on hazardous induced voltage do not apply. In another example, further investigation is required when an equipment ground is found to be of questionable reliability, unless the equipment is treated as energized under final § 1926.960(j).

EEI was concerned about this discussion of engineering analysis in the preamble to the proposed rule (70 FR 34841), commenting:

> This [discussion] is unrealistic: engineering analyses are not made in the field in transmission and distribution work. [Ex. 0227]

OSHA agrees with EEI that engineering analyses are not made in the field. Under this provision of the final rule, employers would conduct any engineering analyses required by this provision off site and supply the requisite information to the employees performing the work.

Section 1926.951, Medical services and first aid

Section 1926.951 sets requirements for medical services and first aid. Paragraph (a) of § 1926.951 emphasizes that the requirements of § 1926.50 apply. (See § 1926.950(a)(2).) Existing § 1926.50 includes provisions for available medical personnel, first-aid training and supplies, and facilities for drenching or flushing of the eyes and body in the event of exposure to corrosive materials.

Mr. Daniel Shipp with the International Safety Equipment Association (ISEA) recommended that the reference in § 1926.50, Appendix A, to ANSI Z308.1–1978, *Minimum Requirements for Industrial Unit-Type First-aid Kits,* be updated to the 2003 edition (Ex. 0211). OSHA did not propose any changes to § 1926.50, nor was that section a subject of this rulemaking. Thus, the Agency is not adopting Mr. Shipp's suggestion. It should be noted, however, that Appendix A to § 1926.50 is not mandatory. The Agency encourages employers to examine the recommendations in the latest edition of the consensus standard, which is ANSI/ISEA Z308.1–2009, when reviewing the guidance in Appendix A to § 1926.50.

Mr. Stephen Sandherr with AGC was concerned that the requirements proposed in § 1926.951 conflicted with the requirements in § 1926.50 and maintained that such a conflict would hinder a contractor's ability to implement safety (Ex. 0160).

OSHA reexamined the requirements in proposed § 1926.951 and found that the requirements for first-aid supplies in proposed paragraphs (b)(2) and (b)(3) in that section conflicted with similar requirements in § 1926.50. Proposed paragraph (b)(2) would have required weatherproof containers if the supplies could be exposed to the weather, whereas existing § 1926.50(d)(2) requires that the contents of first-aid kits be placed in weatherproof containers, with individual sealed packages for each type of item. Further, proposed paragraph (b)(3) would have required that first-aid kits be inspected frequently enough to ensure that expended items are replaced, but not less than once per year. By contrast, existing § 1926.50(d)(2) requires that first-aid kits "be checked by the employer before being sent out on each job and at least weekly on each job to ensure that the expended items are replaced."

As noted earlier, final § 1926.951(a), which requires that employers comply with existing § 1926.50, was adopted without change from the proposal. The Agency is not including proposed paragraphs (b)(2) and (b)(3) in the final rule because these provisions were less restrictive than the requirements of § 1926.50. Including them in the final rule would compromise OSHA's efforts to enforce § 1926.50 on jobsites covered by Subpart V. OSHA notes that the remaining provisions in § 1926.951 apply in addition to those in § 1926.50.

Final § 1926.951(b) supplements § 1926.50 by requiring cardiopulmonary resuscitation (CPR) to help resuscitate electric shock victims.[79] OSHA concludes that the requirements for CPR training in the final rule are supported by the record. This training is required by existing § 1910.269(b)(1), and work under subpart V poses the same electric-shock hazards and requires the same protection against those hazards. As discussed in the summary and explanation for § 1926.953(h), the final rule defines "first-aid training" to include CPR training. Therefore, in final § 1926.951(b), OSHA replaced the proposed phrase "persons trained in first aid including cardiopulmonary resuscitation (CPR)" with "persons with first-aid training." The Agency stresses that CPR training is required by this and other provisions in the final rule for first-aid training.

Electric shock is a serious and ever-present hazard to electric power transmission and distribution workers because of the work they perform on or with energized lines and equipment. CPR is necessary to revive an employee rendered unconscious by an electric shock. As OSHA concluded in the 1994 § 1910.269 rulemaking, CPR must be started within 4 minutes to be effective in reviving an employee whose heart has gone into fibrillation (59 FR 4344–4347; see also 269–Ex. 3–21).

To protect employees performing work on, or associated with, exposed lines or equipment energized at 50 volts or more, OSHA proposed to require that employees with training in first aid including CPR be available to render assistance in an emergency.

OSHA chose 50 volts as a widely recognized threshold for hazardous electric shock.[80] In this regard, several OSHA and national consensus standards recognize this 50-volt threshold. For example, OSHA's general industry and construction electrical standards require guarding live parts energized at 50 volts or more (§§ 1910.303(g)(2)(i) and 1926.403(i)(2)(i)); the general industry electrical standard also requires that electric circuits be deenergized generally starting at 50 volts (§ 1910.333(a)(1)). Similarly, NFPA's *Standard for Electrical Safety in the Workplace* (NFPA 70E–2004) and the National Electrical Safety Code (ANSI/IEEE C2–2002) impose electrical safety requirements starting at 50 volts (Exs. 0134, 0077, respectively). (See, for example, Section 400.16 of NFPA 70E–

[79] In discussing these remaining provisions in this preamble, OSHA generally uses the term "CPR training" to describe the first-aid training required by the provisions. OSHA does not mean to imply by this language that the final provisions do not require first-aid training other than CPR. In fact, as explained later in the preamble, the final rule defines "first-aid training" as training in the initial care, including CPR, performed by a person who is not a medical practitioner, of a sick or injured person until definitive medical treatment can be administered. OSHA is emphasizing "CPR training" in its preamble discussion because that type of first aid is particularly beneficial to workers who are injured by an electric shock.

[80] Although it is theoretically possible to sustain a life-threatening shock below this voltage, it is considered extremely unlikely. (See, for example, Ex. 0428.)

2004, which requires guarding of live parts of electric equipment operating at more than 50 volts, and Rule 441A2 of ANSI/IEEE C2–2002,[81] which prohibits employees from contacting live parts energized at 51 to 300 volts unless certain precautions are taken.)

Many electric shock victims suffer ventricular fibrillation (59 FR 4344–4347; 269–Ex. 3–21). Ventricular fibrillation is an abnormal, chaotic heart rhythm that prevents the heart from pumping blood and, if unchecked, leads to death (*id.*). Someone must defibrillate a victim of ventricular fibrillation quickly to allow a normal heart rhythm to resume (*id.*). The sooner defibrillation is started, the better the victim's chances of survival (*id.*). If defibrillation is provided within the first 5 minutes of the onset of ventricular fibrillation, the odds are about 50 percent that the victim will recover (*id.*). However, with each passing minute, the chance of successful resuscitation is reduced by 7 to 10 percent (*id.*). After 10 minutes, there is very little chance of successful rescue (*id.*). Paragraph (b) of the final rule requires CPR training to ensure that electric shock victims survive long enough for defibrillation to be efficacious. The employer may rely on emergency responders to provide defibrillation.

In the preamble to the proposal, OSHA requested public comment on whether the standard should require the employer to provide automated external defibrillators (AEDs) and, if so, where they should be required. AEDs are widely available devices that enable CPR-trained individuals to perform defibrillation.

Many rulemaking participants recommended that OSHA not adopt a requirement for AEDs. (See, for example, Exs. 0125, 0162, 0167, 0169, 0171, 0173, 0174, 0177, 0200, 0225, 0227; Tr. 635–636, 762–763.) Some commenters argued that there were no injuries for which AEDs would prove beneficial. (See, for example, Exs. 0174, 0200; Tr. 635–636, 762–763.) In this regard, Mr. Steven Semler, commenting on behalf of ULCC, stated:

> [W]hen tragic electric contact accidents do, albeit rarely, occur with respect to line clearance tree trimmers, they tend to involve catastrophic accidental direct contract with high voltage electric supply lines which inherently pass massive amounts of electricity through the victim which irreversibly damages cardiac conductivity altogether—as to which AED's cannot, nor even purport to, rectify . . . . It is, of course, a misnomer that AED's can restart a heart which is stopped from electrical contact or any other reason. The stoppage is known as "asystole" for which an AED is programmed to *not* shock the patient because AED's cannot start a stopped heart—for instance, one whose stoppage is due to destruction of the heart's electrical path, or due to irreversible brain damage, respiratory muscle paralysis, tissue burn, or due to electrical contact which serves to destroy the ability to breathe.
>
> Rather, AED's use is limited solely to cases of cardiac fibrillation—cases of the heart beating in quivering fashion so as to cease effective pumping capacity (and also to rarer situations of ventricular tachycardia where the heart beats very fast). But, as a trauma specialist physician has observed, ventricular fibrillation is a rare occurrence in high voltage electrical contacts, as to which rescue breathing and CPR (currently required) are remedial pending arrival of medical help. [Footnote: Richard F. Edlict, MD, "Burns, Electrical, *www.emedicine.com/plastic/topic491.htm* (7/12/05) . . .]
>
> Given that the unfortunate nature of line clearance tree trimmers cardiac events due to electric contact tend to be catastrophic because of accidental non compliance with the OSHA minimum distance separation from electric supply lines separation requirement, the cardiac events which unfortunately have happened to line clearance tree trimmers have tended to catastrophic, tending to involve cardiac and brain damage of such severity that AED's are not designed to, and cannot, perform a useful purpose. [Ex. 0174; emphasis included in original]

Furthermore, TCIA presented polling data to show that their members have not experienced any occupational incidents for which AED use would have been appropriate to treat the victim (Exs. 0200, 0419).

On the other hand, several rulemaking participants pointed out that AEDs have saved lives (Exs. 0213, 0230). TVA, which has deployed AEDs in both fixed work locations, such as generation plants, and in field service-centers, reported two successful uses of AEDs in a 17-month period (Ex. 0213). IBEW commented that "AED units have proven to be effective in the utility industry. More than one 'save' has occurred" (Ex. 0230). Testifying on behalf of IBEW, Mr. James Tomaseski stated, "[B]ased on what the experts tell you about the need to have AEDs in certain environments, [electric utility work] is [at the] top of the list. We have an aging workforce. The possibilities of sudden cardiac arrest to occur to people in this industry is very high" (Tr. 964).

The Agency concludes that employees performing work covered by subpart V and § 1910.269 are exposed to electric shocks for which defibrillation is needed as part of the emergency medical response to such injuries. The Agency bases this conclusion on the evidence in both this record, as well as the record supporting its decision in the 1994 § 1910.269 rulemaking to require first-aid training, including CPR training, for work covered by that standard. OSHA found in its 1994 § 1910.269 rulemaking that line-clearance tree trimmers were exposed to electric-shock hazards for which CPR would be efficacious (59 FR 4344–4347), and the National Arborist Association (TCIA's predecessor) pointed out that low-voltage electric shock can result from indirect contact with higher voltage sources (269-Ex. 58, 59 FR 4345). OSHA's inspection data amply demonstrate that indirect contacts, such as contacting a power line through a tree branch, do occur in work covered by § 1910.269 and Subpart V (Ex. 0400). Half of the ten line-clearance tree-trimmer electrocutions described in these data resulted from indirect contacts. The experience of TVA and IBEW reinforces the Agency's conclusion that employees performing work covered by Subpart V and § 1910.269 are exposed to electric shocks for which defibrillation is needed as part of the emergency medical response.

Many rulemaking participants argued that work covered by Subpart V would subject AEDs to environmental and other conditions for which the devices are not, or may not be, designed, including:

- Extreme heat (see, for example, Exs. 0169, 0171, 0173, 0177, 0227),
- Extreme cold (see, for example, Exs. 0169, 0171, 0173, 0177, 0227),
- Vibration or jarring (see, for example, Exs. 0169, 0173, 0175),
- Dust (see, for example, Exs. 0169, 0171, 0173, 0175), and
- Humidity and moisture (see, for example, Exs. 0169, 0171, 0173).

For instance, Mr. Wilson Yancey with Quanta Services commented that the conditions to which AEDs would be exposed could "quickly degrade the performance of the equipment and require frequent inspection and maintenance" (Ex. 0169). Ms. Salud Layton with the Virginia, Maryland & Delaware Association of Electric Cooperatives commented, "Most field experience with AED's has been at either fixed sites or carried by ambulances in padded bins/cases inside of heated and cooled ambulance bodies. This is not what the AED's would be exposed to on a utility vehicle" (Ex. 0175). Mr. Thomas Taylor with Consumers Energy noted that manufacturers' instructions tightly control AEDs' storage requirements, explaining:

[81] The 2012 NESC contains a similar requirement in Rule 441A2.

[L]ine truck storage conditions would prohibit the AED from functioning properly and therefore provide no tangible safety benefit to employees. In this regard, the manufacturer instructions for preventing electrode damage states: "Store electrodes in a cool, dry location (15 to 35 degree Celsius or 59 to 95 degrees Fahrenheit". The instruction also states: ["]It is important that when the AED is stored with the battery installed, temperature exposure should not fall below 0 degrees Celsius (32 degrees Fahrenheit) or exceed 50 degrees Celsius (122 degrees Fahrenheit). If the AED is stored outside this temperature range, the auto tests may erroneously detect a problem and the AED may not operate properly.["] [Ex. 0177]

OSHA decided not to include a requirement for AEDs in the final rule because the Agency believes that there is insufficient evidence in the record that AEDs exposed to the environmental extremes typical of work covered by Subpart V and § 1910.269 would function properly when an incident occurs. There is no evidence in the record that AEDs are adversely affected by dust, vibration, or humidity; however, it is clear that line work in many areas of the country would subject AEDs to temperatures above and below their designed operating range of 0 to 50 degrees Celsius. For example, Mr. Frank Owen Brockman with the Farmers Rural Electric Cooperatives testified that temperatures in Kentucky can get as cold as −34 degrees Celsius and as high as 44 degrees Celsius (Tr. 1283). Although the record indicates that the highest of these temperatures is within the operating range of AEDs, OSHA believes that it is likely that the interior of trucks would be significantly hotter than the 50-degree Celsius recommended maximum. Accordingly, there is insufficient evidence in the record for the Agency to determine whether AEDs will work properly in these temperature extremes during use, even if they are stored in temperature-controlled environments as mentioned by some rulemaking participants (see, for example, Ex. 0186; Tr. 965–966).[82]

As explained previously, the Agency stresses that defibrillation is a necessary part of the response to electric shock incidents that occur during work covered by the final rule. OSHA is not adopting a rule requiring AEDs because the record is insufficient for the Agency to conclude that these devices will be effective in the conditions under which they would be used. OSHA encourages employers to purchase and deploy AEDs in areas where they could be useful and efficacious. This action likely will save lives and provide the Agency with useful information on the use of AEDs under a wide range of conditions.

Proposed paragraph (b)(1) would have required CPR training for field crews of two or more employees, in which case a minimum of two trained persons would generally have been required (proposed paragraph (b)(1)(i)), and for fixed worksites, in which case enough trained persons to provide assistance within 4 minutes would generally have been required (proposed paragraph (b)(1)(ii)). Proposed paragraph (b)(1)(i) provided that employers could train all employees in first aid including CPR within 3 months of being hired as an alternative to having two trained persons on every field crew. If the employer chose this alternative for field work, then only one trained person would have been required for each crew. In practice, crews with more than one employee would normally have two or more CPR-trained employees on the crew, since all employees who worked for an employer more than 3 months would receive CPR training. However, employers who rely on seasonal labor (for example, employees hired only in the summer months), or those with heavy turnover, might have some two-person crews with only one CPR-trained employee. Because the Agency was concerned that those new employees might be most at risk of injury, OSHA requested comment on whether allowing employers the option of training all their employees in CPR if they are trained within 3 months of being hired is sufficiently protective. The Agency also requested comment on how this provision could be revised to minimize the burden on employers, while providing adequate protection for employees.

Several commenters shared OSHA's concern with the 3-month delay in CPR training. (See, for example, Exs. 0126, 0187, 0213, 0230) Mr. Rob Land with the Association of Missouri Electric Cooperatives commented that this option was too hazardous because of "the hazards that linemen face and the distinct possibility that [emergency medical services] may be delayed due to remoteness and distances involved" (Ex. 0187). TVA opposed the option because the "3[ ]months when a two-person crew would have only one CPR trained member . . . reduce[s] the level of safety provided" (Ex. 0213). IBEW presented its reasons for opposing the 3-month option, and its recommendation for revising the rule, as follows:

Allowing employers the option of training *all* their employees in CPR if they are trained within 3 months of being hired may not work in all situations. Many utilities engaged in field work have implemented the use of 2-person crews. It is not uncommon for the 2-person crew to perform rubber gloving work on all distribution voltage ranges. It is also not uncommon for a utility to assign a new-hire (less than 3 months of service) as the second person on the 2-person crew. In these work scenarios, the second person would have to be trained in CPR. Waiting 3 months to complete this training would not [be] proper.

* * * * *

The only revision that is necessary is to make it clear that under certain circumstances, new-hires may need to be trained in CPR well before the 3 month window. Manning of crews, especially in the construction industry, cannot always be accomplished using CPR certification as a factor. All employees need to receive the training and the 3 months gives enough flexibility when appropriate[.] [Ex. 0230; emphasis included in original]

Other rulemaking participants supported the provision as proposed. (See, for example, Exs. 0155, 0162, 0174, 0200; Tr. 633–635, 764–765.) Some of them argued that the provision, which was taken from existing § 1910.269(b)(1)(i), has worked well. (See, for example, Exs. 0155, 0200; Tr. 764.) The tree care industry stated that the line-clearance tree trimming industry did not use seasonal labor and argued that the 3-month delay in training new employees in CPR was justified on the basis of high turnover in that industry (Exs. 0174, 0200; Tr. 633–635, 764–765). For example, testifying on behalf of ULCC, Mr. Mark Foster stated:

[T]he current standard reflects a clearly considered balance made by OSHA at the time of adoption of the current standard to allow a three-month phase-in period for CPR compliance for new hires. That policy judgment rests on the fact that there was then an 81 percent turnover rate among line clearance tree trimming employees such that many would not last in employment beyond the initial training period and that that would be very difficult to field crews if new hires had first had to be sent for CPR training.

While the turnover ratio has improved somewhat, it is still staggering[ly] high, [presenting] the same considerations that led to the adoption of the phase-in period in the initial standard. [Tr. 633–634]

In its comment, ULCC indicated that the annual turnover rate in the line-

[82] Some rulemaking participants gave other reasons why OSHA should not require AEDs, including: Costs of acquiring the devices (see, for example, Exs. 0162, 0169, 0173, 0174, 0200, 0227), varying State requirements related to AEDs, such as requirements that they be prescribed by a physician (see, for example, Exs. 0125, 0149, 0227), conflicts with requirements of other Federal agencies, such as the Food and Drug Administration (see, for example, Exs. 0177, 0227), and OSHA's failure to meet all its regulatory burdens, such as burdens imposed by the Small Business Regulatory Enforcement Fairness Act (Ex. 0170). Because OSHA decided not to require AEDs for the reason given in this section of the preamble, it need not consider these other issues.

clearance tree trimming industry is 53 to 75 percent (Ex. 0174).

OSHA decided to restrict the exception permitting a 3-month delay in training employees in first aid, including CPR, to line-clearance tree trimming. The Agency agrees that turnover in the line-clearance tree trimming industry remains high, which was the underlying reason for OSHA's original adoption of the 3-month delay in training for newly hired employees in the 1994 § 1910.269 rulemaking (59 FR 4346–4347). However, as noted by Mr. Land, the provision as proposed leaves employees exposed to hazards when a new employee who has not yet been trained in CPR is the second person in a two-worker crew (Ex. 0187). IBEW also recognized the need to have both employees trained in CPR in many circumstances (Ex. 0230). Finally, turnover rates for the electric utility and power line contractor industries are not nearly as high as that for the tree trimming industry. OSHA estimates that the turnover rates among employees performing electric power generation, transmission, and distribution work ranges from 11 to 16 percent in the construction industries and 3 percent in the generation and utility industries (see Section VI, Final Economic Analysis and Regulatory Flexibility Analysis, later in the preamble). These turnover rates are significantly lower than the turnover rate indicated by ULCC for the line-clearance tree trimming industry.

Because this exception in the final rule applies only to line-clearance tree trimming, which is addressed only in § 1910.269, the Agency is not adopting it in final § 1926.951(b)(1).[83] The corresponding provision in § 1910.269(b)(1)(i) retains the exception providing for a 3-month delay in first-aid training, including CPR, but only for line-clearance tree-trimming work.

These changes will continue to permit employers in the line-clearance tree trimming industry to delay training in first aid, including CPR, to new employees for a reasonable time.

Finally, OSHA notes that it remains concerned that some employees in the line-clearance tree trimming industry might encounter an unnecessary delay in being treated in an emergency. The Agency does not believe that it is reasonable to *unnecessarily* staff crews so that some crews had only one CPR-trained worker, while other crews had three or four. Although the Agency is not addressing this concern in the final rule, OSHA expects employers to staff each tree trimming crew with as many employees trained in first aid as possible, including CPR, to assist in emergencies.

Mr. Steven Theis of MYR Group requested that OSHA provide a similar 3-month grace period for refresher training (Ex. 0162).[84]

OSHA rejects this request. As stated, OSHA is adopting the 3-month delay in CPR training because of the high turnover in the tree trimming industry. There is no evidence in the record that this rationale also applies to refresher training. The Agency expects employers to plan for their employees' training needs and to schedule training in accordance with the standard.

Mr. Paul Hamer, a member of the NFPA 70E Technical Committee on Electrical Safety in the Workplace, recommended that OSHA require first-aid training, including CPR training, for all qualified employees who work on electric circuits of 50 volts or more. He also recommended deleting the 4-minute maximum response time for fixed work locations (Ex. 0228). He argued that the sooner a victim receives CPR, the less cell damage will occur. On the other hand, the American Forest & Paper Association recommended that the 4-minute requirement should be deleted because "no one could ensure ([that is], guarantee) survival of the victim for any particular length of time or that defibrillation would be successful" (Ex. 0237).

OSHA rejects these recommendations. OSHA considered requiring all employees to receive first-aid training, including CPR training, when the Agency developed existing § 1910.269. In lieu of such a requirement, OSHA decided that the best approach was to require a 4-minute maximum response time for fixed work locations and to require at least two trained persons for field work involving crews of two or more employees (existing § 1910.269(b)). OSHA supplemented these provisions with a requirement that two employees be present for work exposing an employee to contact with exposed live parts energized at more than 600 volts (existing § 1910.269(l)(1)).[85] This approach continues to be the best one, as it ensures that persons trained in first aid, including CPR, will be available to employees most at risk of electrocution. The Agency further notes that Mr. Hamer's approach does not address employees working alone in fixed work locations. In these cases, it would still take time for someone to discover the injury, which also would delay first-aid treatment, including CPR.

Two rulemaking participants commented that proposed paragraphs (b)(1)(i) and (b)(1)(ii) were vague (Exs. 0175, 0180). They did not understand the difference between "field work" and "fixed work locations" (*id.*). For example, Ms. Salud Layton with the Virginia, Maryland & Delaware Association of Electric Cooperatives questioned whether the requirements for fixed work locations applied to work at unmanned substations (Ex. 0175). OSHA does not consider an unmanned location to be a fixed work location, as there are normally no employees present. In determining whether to apply paragraph (b)(1) or (b)(2), the Agency would treat an unmanned substation no differently than a manhole or utility pole in the field.

As explained previously in this section of the preamble, OSHA decided not to include proposed paragraphs (b)(2) or (b)(3) in the final rule. The corresponding provisions in existing § 1910.269(b)(2) and (b)(3) are being retained, however. The Agency did not propose to revise these existing requirements and received no comments alleging inconsistencies between existing § 1910.269(b) and § 1910.151, OSHA's general industry standard addressing medical services and first aid.

Section 1926.952, Job Briefing

In § 1926.952, OSHA is requiring that employers ensure that employees conduct a job briefing before each job. This section, which has no counterpart in existing subpart V, is based largely on existing § 1910.269(c).

Most of the work covered by this final rule requires planning to ensure employee safety (as well as to protect equipment and the general public). Typically, electric power transmission and distribution work exposes employees to the hazards of exposed conductors energized at thousands of volts. If the work is not thoroughly

[83] Final § 1926.951(b) uses the term "trained persons," rather than "trained employees," because the individuals with the training do not necessarily need to be employees. For instance, the "trained persons" required by the rule could be self-employed individuals working with a crew of employees.

[84] Although paragraph (b)(1) in the final rule does not address refresher first-aid training, final § 1926.950(b)(4)(iii) contains a general requirement that employees receive additional training when they must employ safety-related work practices (such as administering first aid) that are not normally used during their regular work duties. A note following § 1926.950(b)(4)(iii) indicates that the Agency would consider tasks performed less often than once per year to require retraining. See the discussion of that requirement earlier in this section of the preamble.

[85] The issue of whether the requirement for two employees should apply to voltages of 600 volts or less is discussed under the summary and explanation of final § 1926.960(b)(3), later in this section of the preamble.

planned ahead of time, the possibility of human error that could harm employees increases greatly. To avoid problems, the task sequence is prescribed before work is started. For example, before climbing a pole, the employee must determine if the pole is capable of remaining in place and if minimum approach distances are sufficient, and he or she must determine what tools will be needed and what procedure should be used for performing the job. Without job planning, the worker may not know or recognize the minimum approach-distance requirements or may have to reclimb the pole to retrieve a forgotten tool or perform an overlooked task, thereby increasing employee exposure to the hazards of falling and contact with energized lines.

Employers performing electric power generation, transmission, and distribution work use job briefings to plan the work and communicate the job plan to employees. If the job is planned, but the plan is not discussed with the workers, an employee may perform his or her duties out of order or may not coordinate activities with the rest of the crew, thereby endangering the entire crew. Therefore, OSHA is requiring a job briefing before work is started.

Commenters agreed that job briefings are an important part of electric power work. (See, for example, Exs. 0162, 0173, 0184, 0213, 0241; Tr. 1335.) For instance, Mr. John Masarick of the Independent Electrical Contractors considered job briefings to be "one of the most critical steps for safety on any task" (Ex. 0241). Also, Mr. Stephen Frost of the Mid-Columbia Utilities Safety Alliance voiced his organization's support for job briefings:

> We strongly agree that the job briefing requirement should be written into § 1926.952. Good communications on the job is paramount to safety, and too often workers either choose not to communicate or don't have the skills to communicate their ideas. The job briefing requirement makes it the personal responsibility of every crew member to understand all aspects of the job. The time it takes to do a thorough job briefing is usually 5 to 15 minutes. This is time well-spent to eliminate the possibility of an accident due to workers not knowing or controlling hazards in the work area. [Ex. 0184]

OSHA's experience in enforcing § 1910.269(c), however, shows that some employers are placing the entire burden of compliance with the job briefing requirement on the employee in charge of the work. Therefore, OSHA proposed to include a provision in Subpart V requiring the employer to provide the employee in charge of a job with available information necessary to perform the job safely. This requirement, which is not in existing § 1910.269(c), was in proposed § 1926.952(a)(1). OSHA proposed to add the same requirement to § 1910.269(c). A note following the proposed paragraph indicated that the information provided by the employer was intended to supplement the training requirements proposed in § 1926.950(b) and was likely to be more general than the job briefing provided by the employee in charge. This note also clarified that information covering all jobs for a day could be disseminated at the beginning of the day.

Many commenters recognized the need for the employer to provide certain information to the employee in charge about conditions to which an employee would be exposed. (See, for example, Exs. 0125, 0127, 0186, 0197, 0200, 0219, 0230.) For instance, Mr. Anthony Ahern with Ohio Rural Electric Cooperatives commented:

> The person in charge does need to be given more information than is usually given him/her. They need to know things like the status of the system where they will be working. What are the breaker configurations/settings. Is reclosing enabled or disabled. What is the available fault current at their work site. Are there any other crews working in the area whose work could impact them. For the most part most of this information is of a general type and a company could probably develop a simple form that would be fairly easy to fill out and attach to the usual work orders. This could also be used to document that this information was given and could be used to document the job briefing (tailgate) that the person in charge is required to give the rest of the crew. [Ex. 0186]

Mr. James Junga, the Safety Director of Local 223 of the Utility Workers Union of America (UWUA), also commented on the need for the employer to supply information about the work:

> Requiring the employer to provide adequate information to the employee in charge of a crew is the best way of ensuring that all available information is given to the crew leader. Then and only then the crew leader will be able to brief the crew. Without this requirement a crew leader will be left on his/her own to figure out what the crew is to do. [Ex. 0197]

Some rulemaking participants described the types of information that should be provided to employees. (See, for example, Exs. 0186, 0219; Tr. 402–403, 1373.) Commenters stated that employees in charge need to be provided with the available fault current (Ex. 0186; Tr. 1373), circuit breaker settings, including whether reclosing is enabled (Ex. 0186), whether there are other crews that could affect their work (Ex. 0186), detailed maps and staking sheets (Ex. 0219), and relevant information from outage reports by customers (Tr. 402–403).

Other rulemaking participants addressed when there was a need for the employer to provide information about a job. Mr. Allan Oracion with EnergyUnited EMC maintained: "When a job is not routine, special or large-scale, the employer needs to share any special information with the employee in charge. When the employee in charge is working at a distant location, radio or telephone can be used to communicate information" (Ex. 0219). Mr. Donald Hartley with IBEW stated that the employer needs to provide information "when a contractor's crew performs its first tasks on a host employer's worksite or when the job assignment involves hazards or conditions the crew has not yet encountered" (Tr. 887).

However, many commenters argued that the provision as proposed was inappropriate. (See, for example, Exs. 0125, 0127, 0128, 0163, 0177, 0178, 0200, 0201 0226.) Many argued that the proposed provision was too broad. (See, for example, Exs. 0125, 0127, 0200, 0226.) For instance, Ms. Cynthia Mills of TCIA stated, "We are uncomfortable with the open-ended and subjective nature of the [proposed language], even though we believe it is intended to convey anything 'known to the employer, but unusual,' associated with the work assignment" (Ex. 0200).

Some commenters argued that it was the responsibility of the employee in charge to survey the site and determine all hazards associated with the work. (See, for example, Exs. 0163, 0177, 0178, 0201.) Consumers Energy's submission typified these comments:

> The computer-generated job assignment will contain information related to the location, circuit, and task to be accomplished but no information related to unique hazards of the assignment. It is critical that the employees on the job site survey the site and identify all hazards upon arrival at the site. Removing that responsibility from them would create a false sense of security and a less than desirable knowledge of the hazards present. Safety manuals and written procedures provide general information on hazards that are typically expected in transmission and distribution work. It is the responsibility of the employee in charge to survey the site and identify all hazards upon arrival at the site. [Ex. 0177]

After carefully considering the evidence in the record, OSHA concludes that job briefings are important for ensuring the safety of employees performing work covered by the final rule and that the employer needs to provide adequate information to employees in charge so that a complete job briefing can be conducted. However, OSHA also decided to address

the concerns of commenters that the proposed rule was overly broad or open ended. To this end, OSHA decided to require the employer to 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). Thus, final § 1926.952(a)(1) requires the employer, in assigning an employee or a group of employees to perform a job, to 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).

The Agency notes that final paragraph (a)(1) requires the employer to provide the employee in charge with two types of available information, as noted in § 1926.950(d): (1) Available information on the characteristics of electric lines and equipment, and (2) available information on the conditions of the installation. The Agency also notes that, because § 1926.950(d) limits the determination of characteristics and conditions only to characteristics and conditions that relate to the safety of the work to be performed, this same limitation extends to information that must be provided under final § 1926.952(a)(1). As such, information on the characteristics of electric lines and equipment that must be provided under the final rule (including, for instance, the nominal voltage of lines and equipment, the maximum switching transient voltages, and the presence of hazardous induced voltage) is critical to the selection of proper safety-related work practices and protective equipment.[86] For example, for an employee to select the minimum approach distance required by final § 1926.960(c)(1), he or she needs to know, at a minimum, the nominal voltage on the energized parts. Depending on the employer's established minimum approach distances, the employee also may need to know the maximum transient overvoltage at the worksite. Similarly, an employee needs to know the employer's estimate of incident energy for electric equipment so that he or she can select protective equipment with an appropriate arc rating as required by final § 1926.960(g)(5).

Information on the conditions of the installation that must be provided under the final rule (including, for instance, the condition of protective grounds and equipment grounding conductors, the condition of poles, and environmental conditions relative to safety) also is critical because that information can facilitate the employees' assessment of conditions at the worksite and enable the employees to take appropriate protective measures. For example, an employer may know of defects in a wood pole on which employees are to work because it has a pole-inspection program or has received reports that the pole had defects. Information on such defects can help employees ascertain whether the pole is safe to climb as required by § 1926.964(a)(2). Likewise, information from an employee or a customer that electric equipment is making arcing noises periodically can affect the assessment of whether the employee is exposed to hazards from flames or electric arcs as required by § 1926.960(g)(1).

Thus, the type of information that the employer must provide under the final rule ensures that employees in charge are provided with information relevant to selecting appropriate work practices and protective equipment as required by the final rule. Moreover, because final § 1926.952(a)(1) links the information that the employer must provide the employee in charge to the determination required by § 1926.950(d), final § 1926.952(a)(1) is neither overly broad nor open ended.

The final rule also is narrowly tailored because it limits the information the employer must provide to information that is available to the employer. Under the rule, the question of whether information is available to the employer varies depending on the type of information at issue. First, OSHA presumes that information related to the characteristics of electric lines and equipment is available to the employer. Second, OSHA will deem information on the condition of the installation to be available to the employer only when the information is known by the employer or can be obtained by the employer from existing records through the exercise of reasonable diligence. OSHA does not expect employers to make inspections of worksite conditions to determine the conditions of the installation. The Agency believes that, in most instances, employees will gather additional information about worksite conditions after they reach the worksite. It is nevertheless important that employers provide employees with available information to aid the employees' assessment of worksite conditions and as a secondary precaution in case employees at the site fail to observe a particular condition related to their safety.

Paragraph (a)(1) of 1926.952 applies fully to contractors. Contractors will obtain much or all of the information that they need to comply with § 1926.952(a)(1)—especially information about the characteristics of electric lines and equipment—through the operation of the host-contractor provision in § 1926.950(c).

Several commenters maintained that, in proposing this provision, OSHA did not account for the way work is currently assigned to employees. (See, for example, Exs. 0128, 0163, 0177, 0178, 0201.) For instance, Mr. James Shill of ElectriCities noted that small towns often assign work through a town manager who has insufficient knowledge of the electrical system to provide the required information (Ex. 0178). Further, Mr. James Gartland of Duke Energy described how the process commonly used to assign work to employees at many utilities was at odds with the proposal:

> Requiring a representative of the employer (a manager or supervisor) to provide employees with information necessary to perform a job safely for every job is inconsistent with the use of technology in work management and scheduling. Today's utility workers drive vehicles equipped with computers with wireless communications. They receive job assignments throughout the day from the computer. There frequently is no direct supervisor-employee interface to discuss specific work assignments. The computer-generated job assignment will contain information related to the location, circuit, and task to be accomplished but no information related to unique hazards of this assignment. . . .
>
> It is also inconsistent with industry practices to expect a supervisor/manager to conduct a pre-job briefing at the beginning of the day as mentioned in the Note [to proposed § 1926.952(a)(1)]. Many utilities have employees who report directly to work locations where their supervisor/manager is not present. They are expected to do a pre-job briefing and to assess hazards on their own. There is no company manager/supervisor at the work location to do that assessment. [Ex. 0201]

Some of these commenters also recommended that the Agency make it clear (1) that the rule does not require a face-to-face exchange of information and (2) that the exchange can be provided through work orders or in conjunction with training, safety manuals, and written procedures. (See, for example, Exs. 0177, 0201.)

OSHA appreciates these commenters' concerns and therefore changed the heading for paragraph (a)(1) to read "Information provided by the employer" to help clarify that a separate briefing or face-to-face discussion

[86] In fact, these are the types of information that commenters argued employers should provide. (See, for example, Exs. 0186, 0219; Tr. 402–403, 1373.)

between the employer and the employee in charge is not required. The Agency recognizes that assignments are made through a wide range of mechanisms that do not always provide for face-to-face contact between the employer and the employees performing the work. The rule does not require such contact. The employer is free to use any mechanism that provides the required information before the employees begin their assignment. For example, information could be provided through radio communication with the employee in charge, through a written work order, or through a computer-generated assignment conveyed electronically. Some of this information may be provided through training, in a safety manual, or through written work procedures. However, the Agency will deem such information as meeting paragraph (a)(1) only if it effectively communicates the information about the particular job in question to the employee in charge and if employers respond to these employees' questions about this information as it relates to the particular job in question.

Some commenters suggested that OSHA add certain explicit language to the requirement. (See, for example, Exs. 0125, 0127, 0149, 0169, 0171.) For instance, several commenters recommended revising the rule to read: "In assigning an employee or group of employees to perform a job, the employer shall provide the employee in charge of the job with any additional information known by the employee's supervisor that could affect the safety of the job before the start of the work" (Exs. 0125, 0127, 0149). Other commenters recommended that OSHA clarify that the employer need only provide the information once for work lasting long periods of time (Exs. 0169, 0171).

OSHA rejects these recommended approaches. First, the key issue is whether the information is available to the employer, not whether the supervisor has knowledge of the required information. Second, the final rule requires the employer to provide required information in connection with each job. As stated, the information must be communicated to the employee in charge in an effective manner. Whether a prior communication constitutes an effective communication depends on several factors, such as, but not limited to: The time between the prior communication and the job at hand; the manner in which the prior communication was made; the extent to which the prior job and the present job are similar; and whether any additional or different information needs to be provided with respect to the present job.

OSHA is not including in the final rule the note following proposed paragraph (a)(1). This note was to clarify the meaning of the phrase "available information necessary to perform the job safely." The final rule does not contain that phrase, and OSHA concludes that the note is no longer necessary.

Paragraph (a)(2), which is being adopted without substantive change from the proposal, requires the employee in charge of the job to conduct a job briefing. This provision comes from existing § 1910.269(c).

In the 2005 notice extending the comment period on the proposal, OSHA requested comments on whether the standard should include a requirement to document the job briefing. Comments addressing this issue recommended that the Agency not include such a requirement in the final rule because it would add to employers' paperwork burden without a significant increase in safety. (See, for example, Exs. 0201, 0212.) Considering the lack of record support for such a provision, OSHA is not adopting a requirement to document job briefings in the final rule.

Paragraph (b), which is being adopted without substantive change from the proposal, requires the briefing by the employee in charge to cover: Hazards and work procedures involved, special precautions, energy-source controls, and requirements for personal protective equipment. This requirement also comes from existing § 1910.269(c).

Under final paragraph (c)(1), the employee in charge must conduct at least one briefing before the start of each shift. Only one briefing in a shift is needed if all the jobs to be performed are repetitive or similar. Additional briefings must be conducted pursuant to final paragraph (c)(2) for work involving significant changes in routine that might affect the safety of the employees. For example, if the first two jobs of the day involve working on a deenergized line and the third job involves working on energized lines with live-line tools, separate briefings must be conducted for each type of job. It should be noted that additional job briefings provided under paragraph (c)(2) are separate from the job briefing provided at the start of the shift; these briefings may not be combined. Paragraphs (c)(1) and (c)(2), which duplicate existing § 1910.269(c)(1), have been adopted without substantive change from the proposal.

For routine work, under final paragraph (d)(1), the required briefing need only consist of a concise discussion outlining the tasks to be performed and how to perform them safely. However, if the work is complicated or particularly hazardous or if the employees may not be able to recognize and avoid the hazards involved, then a more thorough discussion is required by paragraph (d)(2). OSHA included a note following this paragraph to clarify that, regardless of how short the discussion is, the briefing must still address all the topics listed in paragraph (b).

OSHA received several comments on proposed paragraphs (d)(1) and (d)(2). These commenters expressed concern that the proposed provisions were vague and provided insufficient guidance on the conditions requiring more detailed job briefings. (See, for example, Exs. 0162, 0175, 0213.) For instance, MYR Group maintained that the proposal did not sufficiently distinguish between work that is "routine" and work that is "complicated" (Ex. 0162; Tr. 1335), and TVA asked the Agency to define "complicated or particularly hazardous" (Ex. 0213).

With final paragraphs (d)(1) and (d)(2), which were taken from existing § 1910.269(c)(2), OSHA recognizes that employees are familiar with the tasks and hazards involved in routine work. However, it is important to take the time to carefully discuss unusual work situations that may pose additional or different hazards to workers. (See also the discussion of § 1926.950(b)(4) earlier in this section of the preamble.) The Agency believes that it is important for the briefing to be as detailed as necessary for the hazards and work practices involved. MYR Group noted that "the general requirement for short discussions could . . . be applied differently depending on the skill and qualification of the employees involved in the work rather than the work itself" (Ex. 0162). This comment interprets the requirement correctly, and the Agency believes that the language in final § 1926.952(d)(1) and (d)(2), which duplicates existing § 1910.269(c)(2), appropriately conveys this meaning. Accordingly, a more detailed discussion is required "[i]f the employee cannot be expected to recognize and avoid the hazards involved in the job." In addition, the Agency has received no formal interpretation requests related to existing § 1910.269(c)(2). Thus, OSHA concludes that the vast majority of employers understand this provision, and the Agency is adopting § 1926.952(d) without change from the proposal.

OSHA recognizes the importance of job planning for all employees. Although employees working alone cannot participate in formal job

briefings, the Agency believes that an employee who works alone needs to plan his or her tasks as carefully and extensively as an employee who works as part of a team. OSHA is aware of several fatalities involving lone employees who could have benefited from better job planning, or perhaps a briefing with the supervisor, before the job started (Ex. 0400). In one such incident, a power line worker working alone was repairing a broken guy. Standing on the ground, the employee had the anchor in place and grabbed the dangling guy to attach it to the anchor. The guy contacted a 7200-volt overhead power line that had not been guarded or insulated. Had the employee properly planned the job, he would have seen that the guy was close to the power line and could have avoided the contact (*id.*).[87] Therefore, paragraph (e), which OSHA took from existing § 1910.269(c)(3), provides that employees working alone do not need to conduct job briefings, but the employer must ensure that that the tasks are planned as if a briefing were required. This provision is being adopted in the final rule without change from the proposal.

4. Section 1926.953, Enclosed Spaces

Section 1926.953 contains requirements for entry into, and work in, enclosed spaces. An "enclosed space" is defined in final § 1926.968 as 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. The hazards posed by enclosed spaces consist of (1) limited access and egress, (2) possible lack of oxygen, (3) possible presence of flammable gases, and (4) possible presence of limited amounts of toxic chemicals. The potential atmospheric hazards are caused by an enclosed space's lack of adequate ventilation and can normally be controlled through the use of continuous forced-air ventilation alone. Practices to control these hazards are widely recognized and are currently in use in electric, telecommunications, and other underground utility industries. Such practices include testing for the presence of flammable gases and vapors, testing for oxygen deficiency, ventilation of the enclosed space, controls on the use of open flames, and the use of an attendant outside the space. These practices already are required by existing § 1910.269(e) for the maintenance of electric power generation, transmission, and distribution installations, and OSHA took the requirements adopted in final § 1926.953 from existing § 1910.269(e).

Paragraph (a) of final § 1926.953, which is being adopted without substantive change from the proposal, sets the scope of the section's provisions. Accordingly, this section applies only to the types of enclosed spaces that are routinely entered by employees engaged in electric power transmission and distribution work and that are unique to underground utility work. Work in these spaces is part of the day-to-day activities performed by some of the employees protected by this final rule. Enclosed spaces covered by this section include, but are not limited to, manholes and vaults that provide employees access to electric power transmission and distribution equipment.

There are several types of spaces that are not covered by final § 1926.953 (or the corresponding general industry provisions in final § 1910.269(e)). If maintenance work is being performed in confined spaces, it may be covered by OSHA's general industry permit-required confined space (permit-space) standard at § 1910.146; this standard applies to all of general industry, including industries engaged in electric power generation, transmission, and distribution work.

In § 1910.146(b), the permit-space standard defines "confined space" and "permit-required confined space." A confined space is a space that: (1) Is large enough and so configured that an employee can bodily enter and perform assigned work; and (2) Has limited or restricted means for entry or exit (for example, tanks, vessels, silos, storage bins, hoppers, vaults, and pits are spaces that may have limited means of entry); and (3) Is not designed for continuous employee occupancy. A permit-required confined space (permit space) is a confined space that has one or more of the following characteristics: (1) Contains or has a potential to contain a hazardous atmosphere; (2) Contains a material that has the potential for engulfing an entrant; (3) Has an internal configuration such that an entrant could be trapped or asphyxiated by inwardly converging walls or by a floor which slopes downward and tapers to a smaller cross-section; or (4) Contains any other recognized serious safety or health hazard.

Section 1926.953 of the final rule applies to "enclosed spaces." By definition, an enclosed space is a permit-required confined space under § 1926.146. An enclosed space meets the definition of a confined space—it is large enough for an employee to enter; it has a limited means of access or egress; and it is designed for periodic, rather than continuous, employee occupancy under normal operating conditions. An enclosed space also meets the definition of a permit space—while it is not expected to contain a hazardous atmosphere, it has the potential to contain one. OSHA also notes that the definition of permit space in the general industry permit-space standard is broader than the definition of enclosed space in § 1926.968. For instance, if a space contains a hazardous atmosphere under normal conditions, that space is a permit space under § 1910.146, but it is not an enclosed space under final § 1910.269 or Subpart V.

Paragraph (b)(6) of § 1926.21 specifies training requirements for employees who enter "confined or enclosed spaces" as defined in § 1926.21(b)(6)(ii).

When § 1926.21(b)(6) applies, it requires employers to: (1) Instruct their employees about confined-space hazards, the necessary precautions to be taken, and protective and emergency equipment required; and (2) comply with any specific regulations that apply to work in dangerous or potentially dangerous areas. An enclosed space under § 1926.953 also is a confined or enclosed space under § 1926.21(b)(6). However, the definition of confined or enclosed space in § 1926.21(b)(6) (like the definition of permit space in the general industry permit-space standard) is broader than the definition of enclosed space in § 1926.968.[88]

Paragraph (b)(6) of § 1926.21 applies to enclosed spaces covered by final § 1926.953 because employers covered under subpart V are not exempt from complying with other applicable provisions in Part 1926 (see § 1926.950(a)(2)). Section 1926.953 is, therefore, different from final § 1910.269(e), which "applies to routine entry into enclosed spaces in lieu of the permit-space entry requirements contained in paragraphs (d) through (k) of § 1910.146." OSHA concludes, however, that an employer that is compliant with § 1926.953 is considered as being in compliance with existing § 1926.21(b)(6) for entry into enclosed

[87] This accident can be viewed at: *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=909119.*

[88] Under § 1926.21(b)(6)(ii), a confined or enclosed space is any space having a limited means of egress, which is subject to the accumulation of toxic or flammable contaminants or has an oxygen deficient atmosphere.

spaces covered by final § 1926.953. Therefore, for all practical purposes, § 1926.953 applies to routine entry into enclosed spaces in lieu of the requirements contained in § 1926.21(b)(6). OSHA is not including the "in lieu of" language in final § 1926.953 because OSHA recently proposed a new standard for confined-space entry during construction work (72 FR 67352, Nov. 28, 2007). OSHA intends to revise § 1926.953 to include appropriate "in lieu of" language when it promulgates the new standard.

Under final § 1926.953(a), entry into an enclosed space to perform construction work covered by Subpart V must meet the permit-space entry requirements of paragraphs (d) through (k) of the general industry permit-space standard at § 1910.146 when the precautions taken under §§ 1926.953 and 1926.965 are insufficient to eliminate hazards in the enclosed space that endanger the life of an entrant or could interfere with escape from the space. This requirement ensures that employees working in enclosed spaces will be afforded protection in circumstances in which the Subpart V provisions are insufficiently protective.[89]

Some employers may *prefer* to comply with § 1910.146 instead of § 1926.953 for entry into enclosed spaces covered by Subpart V. Because the provisions of § 1910.146 protect employees entering enclosed spaces at least as effectively as § 1926.953, OSHA will accept compliance with § 1910.146 as meeting the enclosed-space entry requirements of § 1926.953. OSHA included a note to this effect immediately following final § 1926.953(o). The Agency is adopting the note as proposed.

MYR Group opposed applying the general industry standard for permit spaces to construction work. The company argued that subpart V should not incorporate "standard requirements that have already been rejected for construction work" and recommended that the Agency develop requirements specific "to electrical construction work or through the proposed and pending separate confined space standard for construction" (Ex. 0162).

OSHA disagrees with this comment. The Agency developed the enclosed-space provisions in existing § 1910.269 to protect employees during routine entry into enclosed spaces. As discussed in detail previously, OSHA concluded that the requirements for work on electric power generation, transmission, and distribution installations should generally be the same regardless of whether the work is covered by final § 1910.269 or subpart V. (See the summary and explanation for final § 1926.950(a)(1), earlier in this section of the preamble.) For the purpose of routine entry into these spaces, OSHA concludes that it is appropriate for employers to follow the same rules with respect to both construction and general industry work.

OSHA also is applying the general industry permit-space standard to work in enclosed spaces when the hazards remaining in the enclosed space endanger the life of an entrant or could interfere with escape from the space after an employer takes the precautions required by §§ 1926.953 and 1926.965. This action is necessary because, as OSHA noted in the proposed construction standard for confined spaces, "the existing construction standard for confined and enclosed spaces at 29 CFR 1926.21(b)(6) does not adequately protect construction employees in confined spaces from atmospheric, mechanical, and other hazards" (72 FR 67354). OSHA notes, however, that the references to the general industry standard in final § 1926.953 are included as a placeholder pending the promulgation of the confined spaces in construction standard. OSHA intends to change these references to refer to the construction standard when it promulgates that standard.

Paragraph (a) in final § 1926.953 provides that § 1926.953 does not apply to vented vaults under certain conditions. Permanent ventilation in vented vaults prevents a hazardous atmosphere from accumulating. However, the intake or exhaust of a vented vault could be clogged, limiting the flow of air through the vaults. The employee in such cases would be exposed to the same hazards presented by unvented vaults. Additionally, mechanical ventilation for a vault so equipped may fail to operate. To ensure that the employee is protected from the hazards posed by lack of proper ventilation, the final rule exempts vented vaults only if the employer determines that the ventilation is operating to protect employees. This determination must ensure that ventilation openings are clear and that any permanently installed mechanical ventilating equipment is in proper working order.

Section 1926.953 also does not apply to spaces not designed for periodic entry by employees during normal operating conditions, such as spaces that require energy sources to be isolated or fluids to be drained before an employee can safely enter. These types of spaces include, but are not limited to, boilers, fuel tanks, coal bunkers, and transformer and circuit breaker cases. As explained in the preamble to the 1994 § 1910.269 final rule, the measures required in existing § 1910.269(e) (and, by implication, final § 1926.953) are not adequate to protect employees from the various hazards posed by these types of permit-entry confined spaces (59 FR 4364–4367).

MYR Group commented that subpart V's definition of "enclosed space" was "overly narrow and unclear" because "there is no specific basis for creation of such a broad definition solely for electrical work" (Ex. 0162).

OSHA disagrees with this comment. The Agency derived the definition from the definition of "enclosed space" in existing § 1910.269(x). As explained in the preamble to the 1994 § 1910.269 final rule, OSHA narrowly tailored the definition of "enclosed space" to the protective measures required by existing § 1910.269(e) (59 FR 4364–4367). A broader definition would involve permit spaces presenting hazards against which final § 1926.953 would not offer protection. Therefore, OSHA is adopting the definition of "enclosed space" as proposed. However, OSHA is not adopting the proposed note in final § 1926.968.[90] The proposed note, which appears in existing § 1910.269(x), describes types of spaces that are enclosed, but that do not meet the definition of "enclosed space," and explains that such spaces meet the definition of permit spaces in § 1910.146 and that entries into those spaces must conform to that standard. Although the types of spaces described in the proposed note do not meet the definition of "enclosed space" in either the general industry or construction standard, § 1910.146 does not apply to confined-space entry during construction work. Consequently, the final rule does not include the note to the definition of "enclosed space" in final § 1926.968. OSHA intends to revise § 1926.968 to include an appropriate note to the definition of "enclosed

[89] Section 1926.953 thus functions similarly to corresponding provisions in § 1910.146. An employer need not follow the permit-entry requirements of § 1910.146 for spaces where the hazards have been completely eliminated, or for limited situations in which OSHA permits the use of alternative procedures (§ 1910.146(c)(5) and (c)(7)). The spaces for which alternative procedures may be used are similar to "enclosed spaces," as defined in this final rule, and the alternative procedures themselves are similar to the procedures contained in final § 1926.953 (§ 1910.146(c)(5); 58 FR 4462, 4486–4489, Jan. 14, 1993).

[90] OSHA is not removing the existing note to that definition from final § 1910.269(x).

space" when it promulgates the new standard for confined-space entry during construction work.

Paragraph (b), which is being adopted without substantive change from the proposal, contains the general requirement that employers ensure the use of safe work practices for entry into, and work in, enclosed spaces and for rescue of employees from such spaces. These safe work practices ensure that employees are protected against hazards in the enclosed space and include, among others, the practices specified in paragraphs (e) through (o).

Paragraph (c), which is being adopted without substantive change from the proposal, requires each employee who enters enclosed spaces, or who serves as an attendant, to be trained in the hazards associated with enclosed-space entry and in enclosed-space entry and rescue procedures. This training must ensure that employees are trained to work safely in enclosed spaces and that they will be knowledgeable of the rescue procedures in the event that an emergency arises within the space.

Paragraph (d), which is being adopted without change from the proposal, requires that the employer provide equipment that will assure the prompt and safe rescue of employees from the enclosed space. This requirement is necessary to ensure that employees who are injured in enclosed spaces will be retrieved from the spaces. The equipment must enable a rescuer to remove an injured employee from the enclosed space quickly and without injury to the rescuer or further harm to the injured employee. A harness, lifeline, and self-supporting winch can normally be used for this purpose.

Mr. Leo Muckerheide with Safety Consulting Services recommended that, because of the risk of arc hazards, OSHA should explicitly require nonconductive and flame-resistance-rated rescue equipment that meets ASTM F887, *Standard Specifications for Personal Climbing Equipment* (Ex. 0180). He argued that the general industry confined space standard does not protect against arc-flash and electric-shock hazards and contrasted proposed paragraph (d) with provisions in proposed § 1926.960 that do require protection from these hazards (*id.*).

OSHA rejects this recommendation. First, work in enclosed spaces does not always pose arc-flash or electric-shock hazards. Sometimes, employees enter spaces to take readings or perform inspections; during these activities these hazards are unlikely to be present,[91] or there may be no energized electric equipment present.

Second, addressing arc-flash and electric-shock hazards in § 1926.953 would be unnecessarily duplicative, as these hazards are more appropriately addressed in § 1926.960, which applies to work on or near exposed live parts. When work is performed within reaching distance of exposed energized parts of equipment, final § 1926.960(f) requires the employer to ensure that each employee removes, or renders nonconductive, all exposed conductive articles, unless such articles do not increase the hazards associated with contact with the energized parts. This provision covers conductive articles on harnesses. Paragraph (c)(1)(iii) of final § 1926.960 requires the employer to ensure that employees do not take conductive objects, such as conductive lifelines, closer to energized parts than the employer's established minimum approach distances, unless the live parts or conductive objects are insulated.[92] Because, in a rescue situation, the attendant would not have control over how close the lifeline got to exposed energized parts, any lifeline would have to be insulated, or the live parts would have to be insulated, to protect the attendant and the entrant against electric shock. Paragraph (g)(1) of final § 1926.960 requires the employer to assess the workplace to determine if each employee is exposed to hazards from flames or electric arcs. This assessment can guide the selection of rescue equipment that can effect safe rescue when employees are exposed to these hazards. If there is a risk that an electric arc could occur in an enclosed space, then the rescue equipment must be capable of withstanding that hazardous condition.

Some conditions within an enclosed space, such as high temperature and high pressure, make it hazardous to remove a cover from the space. For example, if high pressure is present within the space, the cover could be blown off in the process of removing it. Paragraph (e), which is being adopted without substantive change from the proposal, protects against these hazards by requiring a determination of whether it is safe to remove the cover. This determination must include checking for the presence of any atmospheric pressure or temperature differences (generally between the inside and outside of the enclosed space) and evaluating whether there might be a hazardous atmosphere in the space. Furthermore, any condition making it unsafe for employees to remove the cover must be eliminated (that is, reduced to the extent that it is no longer unsafe) before the cover is removed. A note following paragraph (e) clarifies that this determination may consist of checking the conditions that might foreseeably be inside the enclosed space. For example, the cover could be checked to see if it is hot and, if it is fastened in place, it could be loosened gradually to release any residual pressure. The note also clarifies that, to evaluate whether there might be a hazardous atmosphere in the space, an evaluation needs to be made of whether conditions at the site could cause a hazardous atmosphere to accumulate in the space.

Paragraph (f), which is being adopted without substantive change from the proposal, requires that, when covers are removed, openings to enclosed spaces be promptly guarded to protect employees from falling into the space and to protect employees in the enclosed space from being injured by objects entering the space. The guard could be a railing, a temporary cover, or any other barrier that provides the required protection.

Paragraph (g), which is being adopted without substantive change from the proposal, prohibits employees from entering enclosed spaces that contain a hazardous atmosphere unless the entry conforms to the general industry permit-space standard at § 1910.146. Accordingly, if an entry is to be made while a hazardous atmosphere is present in the enclosed space, the entry must conform to the general industry permit-required confined spaces standard at § 1910.146.[93] Once the hazardous atmosphere is removed (for example, by ventilating the enclosed space), employees may enter the enclosed space following the provisions in § 1926.953.

The use of the term "entry" in this paragraph of § 1926.953 is consistent with the use of that term in § 1910.146, and OSHA proposed to include the § 1910.146 definition of "entry" in Subpart V. Two commenters objected to the proposed definition of "entry" on the basis that the definition would

[91] It is possible under certain circumstances that employees taking readings or performing inspection activities could be exposed to arc-flash hazards. See the discussion of arc-flash hazard assessment under the summary and explanation for final § 1926.960(g)(1), later in this section of the preamble.

[92] There is a third exception associated with live-line barehand work, which is generally inapplicable in enclosed spaces.

[93] As stated previously, the references to the general industry standard in final § 1926.953 are included as a placeholder pending the promulgation of the confined spaces in construction standard. OSHA intends to change these references to refer to the construction standard when it promulgates that standard.

prevent them from hanging a tag in the chimney of a manhole with a fault (Exs. 0157, 0227). Consolidated Edison Company of New York (ConEd) described their opposition to the proposed definition of "entry" as follows:

> In order to comply with § 1910.269(t)(7)(i), Con Edison utilizes an identification system for structures that have cable and joint abnormalities. This system requires the identifying crew to hang a tag (in our nomenclature, a D-Fault tag) in the chimney of the manhole. This red tag is a clear indication to any other personnel who may attempt to enter the structure that the entry should not be made. This tagging system is an integral part of our compliance method and of protecting our employees. If OSHA adds the definition as proposed, it will prevent us from breaking the plane of the opening and hence prevent us from hanging the tag. This process will reduce, not increase the safety of our employees and as such will have the opposite effect from what OSHA is trying to accomplish. [Ex. 0157]

EEI recommended instead that "that the Agency grant electric utilities an [exemption from] the definition for [§ 1910.269](t)(7) Protection against faults, to allow utilities to properly comply" (Ex. 0227).

OSHA rejects ConEd's recommendation. Paragraph (g) of final § 1926.953 does not preclude employers from hanging tags in the chimney of a manhole with a fault. To the contrary, the rule permits entry into an enclosed space that contains a hazardous atmosphere if entry conforms to the general industry permit-space standard. Moreover, if there is no hazardous atmosphere in the space, employees may enter when the entry conforms to § 1926.953. OSHA concludes that the proposed definition is, therefore, appropriate as it applies to final § 1926.953 and the corresponding requirements in final § 1910.269(e).

OSHA also rejects EEI's recommendation, because it is unnecessary. The definition of "entry," as proposed and adopted, applies only to the use of that term in final §§ 1910.269(e) and 1926.953. The definition does not apply to final § 1910.269(t)(7)(i) or § 1926.965(h)(1). (See the summary and explanation for final § 1926.965(h)(1) for the response to ConEd's and EEI's concerns that this provision, and its counterpart in § 1910.269(t)(7)(i), would preclude an employer from hanging a tag in the chimney of a manhole or vault to indicate the presence of a faulted cable.)

Paragraph (h), which has been adopted with clarifying revisions from the proposal, requires an attendant with first-aid training, including CPR, to be immediately available outside the enclosed space to provide assistance when a hazard exists because of traffic patterns in the area of the opening used for entry.[94] This paragraph does not prohibit the attendant from performing other duties outside the enclosed space, as long as those duties do not distract the attendant from monitoring employees who are in the enclosed space (entrants) and ensuring that it is safe to enter and exit the space. This paragraph has two purposes: To protect the entrant from hazards involving traffic patterns while the entrant is entering or exiting the space and to provide assistance in an emergency.

Mr. Frank Brockman with Farmers Rural Electric Cooperative Corporation noted that attendants should never be allowed to enter manholes or confined spaces (Ex. 0173).

The final rule, like the proposal, requires the attendant to remain immediately available outside the enclosed space during the entire entry. If the attendant were permitted to enter the enclosed space during entry, he or she might not be able to assist the entrant. For example, if traffic-pattern hazards are present in the area of the opening to the enclosed space and if the attendant enters the space, then both the attendant and the workers he or she is protecting would be vulnerable upon leaving the enclosed space because no one would be present to minimize or control the traffic-pattern hazards. Therefore, the final rule specifies that the attendant must remain outside the enclosed space during the entire entry process. It should be noted that the rescue equipment required by paragraph (d) will enable the entrant to rescue the entrant from the space before administering any necessary first aid.

Mr. Lee Marchessault of Workplace Safety Solutions recommended that paragraph (h) require the attendant to be trained in CPR, in addition to first-aid training (Ex. 0196; Tr. 575). He noted that the electrical hazards in the space, as well as other hazards, might present a need for CPR (Tr. 598).

OSHA is clarifying paragraph (h) in the final rule. The proposed rule required training in first aid, including CPR, so that the attendant could provide emergency assistance in case of injury. This is the type of training required by § 1926.951(b). However, the reference to § 1926.951(b)(1) in the proposal likely caused Mr. Marchessault to misinterpret the requirement. Therefore, the Agency included a definition of "first-aid training" in § 1926.968 in the final rule. That definition states that first-aid training is 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. The definition clarifies that, wherever first-aid training is required by the final rule, CPR training must be included.[95] OSHA also dropped the proposed cross-reference to § 1926.951(b)(1), as it is no longer necessary.

Mr. Anthony Ahern with the Ohio Rural Electric Cooperatives recommended that an attendant always be available for enclosed-space operations, not just when traffic-pattern hazards exist (Ex. 0186).

OSHA is not adopting this recommendation. By definition, an enclosed space contains a hazardous atmosphere only under abnormal conditions. The Agency previously concluded that these spaces do not present the type of atmospheric hazards that warrant the presence of an attendant after the employer takes precautions such as those required by § 1926.953. (See, for example, 58 FR 4485–4488.) In addition, as provided in final § 1926.953(a), when a hazardous atmosphere is present after the employer takes the precautions required by this section, paragraphs (d) through (k) of OSHA's general industry permit-space standard, § 1910.146, which do require attendants, apply. Therefore, the Agency concluded that, when paragraph (h) applies, the only hazards (other than electrical) that necessitate the presence of an attendant while work is being performed in an enclosed space are traffic-pattern hazards in the area of the opening used for entering and exiting the enclosed space. OSHA notes that even if no traffic-pattern hazards are present, an attendant is required under § 1926.965(d) of the final rule while work is being performed in a manhole or vault containing energized electric equipment. A note to this effect follows final § 1926.953(h).

Mr. Leo Muckerheide with Safety Consulting Services commented that the purpose of proposed paragraph (h) was confusing because the purpose of the

[94] Typically, workers direct traffic away from the work area using traffic control devices, as required by § 1926.967(g). When the resultant traffic patterns (that is, the flow of traffic) could bring vehicles close to the enclosed space entrance (for example, when the work reduces the number of traffic lanes), the employer must provide an attendant.

[95] The definition also clarifies that CPR training includes resuscitation techniques both for the heart and for the lungs.

sentence—that is, protecting entrants from traffic-pattern hazards—differs from the attendant's duties as noted in the second sentence—monitoring employees within the space. He recommended that OSHA revise the second sentence of that paragraph as follows:

> That person is not precluded from performing other duties outside the enclosed space if these duties do not distract the attendant from monitoring the traffic patterns outside the enclosed space. [Ex. 0180]

OSHA rejects Mr. Muckerheide's recommended language. Part of the attendant's duty to monitor employees in the space is to warn entrants preparing to exit an enclosed space about hazards involving traffic patterns. If the attendant is watching traffic patterns instead of monitoring the entrant, the entrant might not receive warnings about that traffic before exiting the space. When the entrant is ready to exit the space, the attendant can then monitor or direct traffic and let the entrant know when it is safe to exit the space. On the other hand, OSHA agrees with Mr. Muckerheide that the duties of the attendant may not be clear from the language of the provision as proposed. Therefore, OSHA revised the language in final paragraph (h) to make it clear that ensuring that it is safe to enter and exit an enclosed space is part of the attendant's duties.

Paragraph (i), which is being adopted without change from the proposal, requires that test instruments used to monitor atmospheres in enclosed spaces have a minimum accuracy of ±10 percent and be kept in calibration. This provision will ensure that test measurements are accurate so that hazardous conditions will be detected when they arise. The accuracy of instruments used for testing the atmosphere of these spaces is important for employee safety, and calibration is critical to test-instrument accuracy. As noted in the preamble to the proposal and to the 1994 § 1910.269 final rule, OSHA considers ±10 percent to be the minimum accuracy needed to detect hazardous conditions reliably (70 FR 34849, 59 FR 4369).

Two commenters objected to the proposed requirements (Exs. 0128, 0227). EEI recommended that the standard only require "that test instruments be kept in calibration using the recommendations set forth by the specific manufacturer" and not address accuracy (Ex. 0227). Mr. Mark Spence of Dow Chemical Company argued that OSHA did not demonstrate that the provision was necessary or that calibration has been a problem (Ex. 0128). He stated that the general industry permit-space standard did not contain such a requirement, but only requires that the atmospheres in spaces be monitored (*id.*).

OSHA rejects the recommendations from these two commenters. Mr. Spence is incorrect. The permit-space standard requires test equipment to be calibrated. As mentioned previously, § 1910.146(c)(5) contains requirements for alternative procedures for permit spaces that are analogous to the enclosed-space requirements contained in § 1926.953 of the final rule. Paragraph (c)(5)(ii)(C) of § 1910.146 requires atmospheric testing using a calibrated test instrument. Paragraph (d) of § 1910.146, which contains requirements for permit-required confined-space programs, specifies, at paragraph (d)(4)(i), that employers maintain "[t]esting and monitoring equipment needed to comply with paragraph (d)(5)." As OSHA concluded in the preamble to the general industry permit-space final rule, if test equipment "is properly selected, calibrated, and maintained . . ., the testing and monitoring needs for entry and work in permit-required confined spaces can be effectively met" (58 FR 4498). Thus, the use of inaccurate or uncalibrated test instruments does not meet the permit-space standard.

OSHA rejects EEI's recommendation that the standard not address accuracy. The Agency concluded in the 1994 § 1910.269 rulemaking that the requirement for test instruments to be accurate within ±10 percent was reasonably necessary for the protection of employees (59 FR 4369). OSHA continues to believe that the accuracy of instruments used for testing the atmosphere of these spaces is important, and EEI offered no evidence to the contrary.

OSHA also rejects EEI's assertion that equipment calibrated to manufacturers' specification is an adequate substitute for test equipment accuracy. Calibration and accuracy are not synonymous. A calibrated test instrument is one that has been compared to a standard reference source for the substance (oxygen, or a toxic or flammable gas) to be measured. Accuracy is a measure of the precision with which the substance can be measured. An oxygen meter, for example, with an accuracy of ±20 percent could give a reading as much as 20 percent above or below the actual oxygen content even when it is properly calibrated. It is evident that this calibrated instrument would not meet the final rule's minimum accuracy requirement of ±10 percent.

Several commenters recommended that OSHA include in the final rule specific requirements on how to keep instruments calibrated. (See, for example, Exs. 0196, 0211, 0227.) For instance, ISEA recommended that OSHA refer employers and employees to the Agency's Safety and Health Information Bulletin "Verification of Calibration for Direct-Reading Portable Gas Monitors" (SHIB 05–04–2004) for information on this topic (Ex. 0211).[96] As noted earlier, EEI recommended that test instruments be calibrated in accordance with manufacturers' instructions (Ex. 0227). Another commenter, Mr. Lee Marchessault with Workplace Safety Solutions agreed that the standard should require calibration in accordance with manufacturers' instructions because test instruments "may go out of calibration 2 hours after being calibrated" (Ex. 0196).

OSHA is not adopting these recommendations. The Agency decided to adopt a performance-based approach for this requirement to provide compliance flexibility. OSHA considers a test instrument to be "kept in calibration," as required by paragraph (i), when the employer follows the manufacturers' calibration instructions or other reasonable guidelines for the calibration of the instrument involved. The Agency anticipates that most employers will follow manufacturers' instructions. However, these instructions might not be available if the manufacturer has gone out of business. In addition, there are other sources of information on proper calibration methods. As mentioned earlier, ISEA noted one appropriate source of information that can be used instead, although the Agency decided against including a reference to that publication in the final rule.

Mr. Kevin Taylor with the Lyondell Chemical Company asked for clarification of the requirement that test instruments have a minimum accuracy of ±10 percent (Ex. 0218). He inquired whether that level of accuracy was needed for each measured gas or whether the accuracy measurement was based on total detection of gases.

OSHA clarifies that the accuracy required by the final rule pertains to each gas being measured. Moreover, the accuracy of the instrument must be determined based on the threshold quantities that would make the atmosphere within the space hazardous (as per the definition of "hazardous atmosphere" in § 1926.968). For

[96] This document is available on the OSHA Web site at: *http://www.osha.gov/dts/shib/shib050404.pdf.*

example, a particular enclosed space could potentially contain hazardous levels of methane, carbon dioxide, and carbon monoxide, as well as insufficient levels of oxygen. The instrument or instruments used to test the space in this example must be accurate to within ±10 percent of: (1) A 0.5-percent concentration of methane (which is 10 percent of its lower flammable limit),[97] (2) the permissible exposure limits (PELs) contained in Subpart D for both carbon dioxide and carbon monoxide (9,000 and 55 mg/m^3, respectively), and (3) atmospheric concentrations of oxygen at 19.5 percent. It is important for the test instrument to be accurate near the threshold because those are the critical values for determining whether or not a space is hazardous.

As noted earlier, because of the lack of adequate ventilation, enclosed spaces can accumulate hazardous concentrations of flammable gases and vapors, or an oxygen deficient atmosphere could develop. It is important to keep concentrations of oxygen and flammable gases and vapors at safe levels; otherwise, an explosion could occur while employees are in the space, or an oxygen deficiency could lead to suffocation of an employee. Toward these ends, paragraphs (j) through (o) of the final rule address the testing of the atmosphere in the space and ventilation of the space. OSHA notes that the specific testing requirements in paragraphs (j), (k), and (o) must be met irrespective of the results of the employer's evaluation performed under paragraph (e). The evaluation performed under paragraph (e) serves only to ensure that it is safe to remove the cover and will not determine whether an enclosed space contains a hazardous atmosphere. The testing required by paragraphs (j), (k), and (o) will ensure, as required by paragraph (g), that employees not enter an enclosed space while it contains a hazardous atmosphere unless they follow the requirements of the general industry permit-space standard.

Paragraph (j), which is being adopted without substantive change from the proposal, requires that, before an employee enters an enclosed space, the atmosphere in the space be tested for oxygen deficiency and that the testing be done with a direct-reading meter or similar instrument capable of collecting and immediately analyzing data samples without the need for off-site evaluation. Continuous forced air-ventilation is permitted as an alternative to testing. However, procedures for such ventilation must ensure that employees are not exposed to the hazards posed by oxygen deficiency.[98] (See also paragraph (m) for additional requirements relating to ventilation of the space.)

Paragraph (k), which is being adopted without change from the proposal, requires that, before employees enter an enclosed space, the internal atmosphere of the space be tested for flammable gases and vapors. If the results of the test indicate the presence of a hazardous atmosphere, employees may not enter under the procedures specified by § 1926.953. (See § 1926.953(g).) So that the results are accurate and relevant to the atmosphere in the space at the time of employee entry, testing must be performed with a direct-reading meter, or similar instrument, capable of collecting and immediately analyzing data samples without the need for off-site evaluation. The flammability test required by this paragraph must be performed after oxygen testing and ventilation required by paragraph (j) demonstrate that the enclosed space has sufficient oxygen for an accurate flammability test.

If flammable gases or vapors are detected or if an oxygen deficiency is found, paragraph (l), which is being adopted without substantive change from the proposal, requires the employer to provide forced-air ventilation to maintain safe levels of oxygen and to prevent a hazardous concentration of flammable gases or vapors from accumulating. As an alternative to ventilation, an employer may use a continuous monitoring system that ensures that no hazardous atmosphere develops and no increase in flammable gas or vapor concentrations above safe levels occur if flammable gases or vapors are detected at safe levels. The language in the final rule clarifies that the monitoring must ensure that concentrations of flammable gases and vapors do not increase above safe levels (as opposed to not increasing at all). The definition of hazardous atmosphere contains guidelines for determining whether the concentration of a substance is at a hazardous level. OSHA is including a note to this effect after paragraph (l). An identical note appears after paragraph (o). OSHA changed the title of this paragraph in the final rule to "Ventilation, and monitoring for flammable gases or vapors" to accurately reflect the contents of the paragraph.

Paragraph (m), which is being adopted without substantive change from the proposal, contains specific requirements for the ventilation of enclosed spaces. When forced-air ventilation is used, it must begin before entry is made and must be maintained long enough for the employer to be able to demonstrate that a safe atmosphere exists before employees are allowed to enter the space. To accomplish this, the ventilation must be maintained long enough to purge the atmosphere within the space of hazardous levels of flammable gases and vapors and to supply an adequate concentration of oxygen.

OSHA decided not to specify a minimum number of air changes before employee entry into the enclosed space is permitted. Instead, the Agency places the burden on the employer to ensure that the atmosphere is safe before such entry. The employer can discharge this duty either by testing to determine the safety of the atmosphere in the space or by a thorough evaluation of the air flow required to make the atmosphere safe. In this way, the safety of employees working in enclosed spaces will not be dependent on speculation by a supervisor or an employee.[99]

Paragraph (m) also requires the air provided by the ventilating equipment to be directed at the immediate area within the enclosed space where employees are at work. The forced-air ventilation must be maintained the entire time the employees are present within the space. These provisions ensure that a hazardous atmosphere does not reoccur where employees are working.

NIOSH recommended that "the atmosphere in a confined space be tested before entry and monitored continuously while workers are in the confined space to determine if the atmosphere has changed due to the work being performed" (Ex. 0130). NIOSH identified its publication "Worker Deaths in Confined Spaces: A Summary of NIOSH Surveillance and Investigative Findings," Publication No. 94–103, as evidence of the need for continuous monitoring (*id.*).

As explained earlier in this section of the preamble, the final rule requires the atmosphere in enclosed spaces to be tested before entry. OSHA concludes, however, that continuous monitoring of enclosed spaces is unnecessary. By

[97] The lower flammable limit for methane is 5 percent, and 10 percent of that value is 0.5 percent.

[98] The definition of "hazardous atmosphere" determines what concentrations of oxygen are considered hazardous. (See § 1926.968.) Paragraph (g) of final § 1926.953 prohibits entry into an enclosed space while a hazardous atmosphere is present.

[99] This discussion, which also appeared in the preamble to the proposal, responds to one commenter's request for clarification of how the employer could demonstrate that the atmosphere in the enclosed space is safe (Ex. 0186).

definition, enclosed spaces contain a hazardous atmosphere only under abnormal conditions. Thus, enclosed spaces almost never contain the types of conditions that will cause a hazardous atmosphere to reoccur after employers implement the precautions required by § 1926.953 (such as forced-air ventilation). If these precautions are not sufficient to keep the atmosphere in the space safe, then the space would not qualify for entry under § 1926.953, and entry could only proceed under the general industry permit-required confined space standard, as specified by paragraph (a) of that section. Therefore, OSHA has not adopted NIOSH's recommendation in the final rule.

Two commenters noted that proposed paragraph (m) might be impossible to implement under certain conditions and recommended that the final rule recognize these conditions (Exs. 0128, 0224). One of these commenters, Dow Chemical Company, noted that it is not always possible to test atmospheric conditions before entry into an enclosed space (Ex. 0128). The other commenter, the Alabama Rural Electric Association of Cooperatives, maintained that it was not always feasible to use forced-air ventilation because of space constraints (Ex. 0224).

OSHA concludes that no changes to paragraph (m) are necessary. The final rule, as with the proposal, recognizes that the enclosed-space procedures might not adequately protect employees in some circumstances. Paragraph (a) of the final rule requires that employers follow the general industry permit-space standard at § 1910.146 whenever the precautions required by final §§ 1926.953 and 1926.965 are insufficient to adequately control the hazards posed by the space. These conditions include any conditions that make complying with those two sections in this final rule infeasible. Therefore, OSHA is including paragraph (m) in the final rule as proposed.

To ensure that the air supplied by the ventilating equipment provides a safe atmosphere, paragraph (n), which is being adopted without substantive change from the proposal, requires the air supply to be from a clean source and prohibits it from increasing the hazards in the enclosed space. For example, the final rule prohibits positioning the air intake for ventilating equipment near the exhaust from a gasoline or diesel engine because doing so would contaminate the atmosphere in the enclosed space.

The use of open flames in enclosed spaces is safe only when flammable gases or vapors are not present in hazardous quantities. For this reason, final paragraph (o), which is being adopted without change from the proposal, requires additional testing for flammable gases and vapors if open flames are to be used in enclosed spaces. The tests must be performed immediately before the open-flame device is used and at least once per hour while the device is in use. More frequent testing is required if conditions indicate the need for it. Examples of such conditions include the presence of volatile flammable liquids in the enclosed space and a history of hazardous quantities of flammable vapors or gases in such a space.

5. Section 1926.954, Personal protective equipment

Final § 1926.954 contains requirements for personal protective equipment (PPE). Paragraph (a), which is being adopted without change from the proposal, clarifies that PPE used by employees during work covered by Subpart V must meet Subpart E of Part 1926.

Mr. Daniel Shipp with ISEA recommended that OSHA update the national consensus standards incorporated by reference in Subpart E (Ex. 0211). He pointed out, for example, that § 1926.100, which covers head protection, incorporates two outdated ANSI standards, namely ANSI Z89.1–1969, *Safety Requirements for Industrial Head Protection,* and ANSI Z89.2–1971, *Industrial Protective Helmets for Electrical Workers (id.).*

Updating the national consensus standards incorporated by reference in Subpart E is beyond the scope of this rulemaking, so OSHA is not adopting Mr. Shipp's recommendation in this final rule. However, on June 22, 2012, OSHA published a direct final rule updating its head protection standard in Subpart E (77 FR 37587–37600).[100] On November 16, 2012, OSHA published a notice confirming the effective date of the direct final rule (77 FR 68684; effective date—September 20, 2012). That rulemaking action updates the national consensus standard for head protection incorporated in Subpart E of the construction standards as recommended by Mr. Shipp.

The preamble to the proposal noted that OSHA had separately proposed regulatory language for the general PPE standards to clarify that employers are generally responsible for the cost of PPE (70 FR 34868–34869; 64 FR 15402, Mar. 31, 1999). OSHA published the final rule on employer payment for PPE on November 15, 2007 (72 FR 64342). The final rule on employer payment for PPE requires employers to pay for the PPE used to comply with OSHA standards, with a few exceptions. The exceptions include: (1) Everyday clothing, such as longsleeve shirts, long pants, street shoes, and normal work boots; and (2) ordinary clothing, skin creams, or other items, used solely for protection from weather, such as winter coats, jackets, gloves, parkas, rubber boots, hats, raincoats, ordinary sunglasses, and sunscreen. (See §§ 1910.132(h) and 1926.95(d).)

Employers must pay for fall protection equipment and other PPE used by employees in compliance with this final rule to the extent required by § 1926.95(d), the general construction rule regarding payment for PPE, or § 1910.132(h), the general rule regarding payment for PPE in general industry. (See 72 FR 64369 (explaining that the general PPE-payment provisions "apply to all OSHA standards requiring PPE"); see also the March 16, 2009, letter of interpretation to Mr. William Mattiford[101] (employers must pay for body belts, positioning straps, and pole- and tree-climbing equipment in accordance with § 1910.132(h)) and the May 1, 2008, letter to Mr. Gil Niedenthal[102] (employers must pay for body belts and pole climbers in accordance with § 1910.132(h)).)

OSHA included a note to final § 1926.954(a) to indicate that § 1926.95(d) sets employer payment obligations for the PPE required by subpart V, including, but not limited to, the fall protection equipment required by final § 1926.954(b), the electrical protective equipment required by final § 1926.960(c), and the flame-resistant and arc-rated clothing and other protective equipment required by final § 1926.960(g). (See the summary and explanation for § 1926.960(g), later in this section of the preamble, for a discussion of the issue of employer payment for flame-resistant and arc-rated clothing.)

Paragraph (b) of the final rule sets requirements for personal fall protection systems. Subpart M of part 1926, which sets requirements for fall protection for

[100] OSHA also updated its consensus standards for general industry and maritime on September 9, 2009 (74 FR 46350). The Agency again updated the general industry and maritime standards with the June 22, 2012, direct final rule because OSHA published the proposal for the 2009 final rule before ANSI updated its head-protection standard that year.

[101] The letter of interpretation to Mr. Mattiford is available at *http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=27014.*

[102] The letter of interpretation to Mr. Niedenthal is available at *http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=27091.*

construction, contains provisions covering two types of personal fall protection systems: Personal fall arrest systems, addressed in § 1926.502(d), and positioning device systems, addressed in § 1926.502(e). Subpart M defines a "personal fall arrest system" as a system used to arrest an employee in a fall from a working level. It consists of an anchorage, connectors, and body harness and may include a lanyard, deceleration device, lifeline, or suitable combinations of these. (See § 1926.500(b).) Personal fall arrest systems are designed to safely arrest the fall of an employee working on a horizontal or vertical surface.

Subpart M defines a "positioning device system" as a body belt or body harness system rigged to allow an employee to be supported on an elevated vertical surface, such as a wall, and work with both hands free while leaning. (See § 1926.500(b).)

Positioning device systems are designed to support an employee working on a vertical surface so that the employee can work with both hands without falling. Proposed Subpart V contained requirements for "work positioning equipment," which is equivalent to "positioning device system" as that term is defined in subpart M. (See the summary and explanation for final § 1926.954(b)(2), later in this section of the preamble.)

A third form of personal fall protection system, which is not specifically addressed in Subpart M, is a tethering, restraint, or travel-restricting system. OSHA's steel erection standard in Subpart R of Part 1926 contains requirements for "fall restraint systems," which it defines as a fall protection system that prevents the user from falling any distance. The system consists of either a body belt or body harness, along with an anchorage, connectors and other necessary equipment. The other components typically include a lanyard, and may also include a lifeline and other devices. (See § 1926.751.[103])

Fall restraint, tethering, and travel-restricting equipment are all designed to prevent employees from falling, in some cases by restraining an employee's access to unprotected edges (restraint, tethering, and travel-restricting equipment) and in other cases by holding the employee in place to prevent falling (restraint equipment).

IBEW recommended that the fall protection provisions in proposed paragraph (b), and in its general industry counterpart, proposed § 1910.269(g)(2), contain a reference to IEEE Std 1307, *Standard for Fall Protection for Utility Work* (Ex. 0230; Tr. 904–905, 983–984). The union noted that this is the only consensus standard addressing specific fall protection issues for the utility industry (Ex. 0230).

OSHA agrees that this consensus standard provides useful information to help employers comply with some provisions of the final rule and added the IEEE standard to the list of reference documents in Appendix G to subpart V and Appendix G to § 1910.269.[104] The Agency is not, however, referencing IEEE Std 1307 in § 1926.954 of the final rule. OSHA made substantial changes to the fall protection requirements in the final rule, and the IEEE standard does not reflect all of the final rule's requirements. For example, on and after April 1, 2015, final § 1926.954(b)(3)(iii)(C) generally does not permit qualified employees to climb poles, towers, or similar structures without fall protection. (See the summary and explanation for final § 1926.954(b)(3)(iii), later in this section of the preamble.) In contrast, section 6.2.1 of IEEE Std 1307–2004 permits qualified climbers to climb poles, towers, and similar structures without fall protection (Ex. 0427).[105]

Proposed paragraph (b)(1) provided that personal fall arrest systems had to meet the requirements of Subpart M of Part 1926. Existing § 1910.269(g)(2)(i) already contains a similar requirement. A note following proposed paragraph (b)(1) indicated that this provision would apply to all personal fall arrest systems used in work covered by subpart V. OSHA is not including this note in the final rule as it is unnecessary.

OSHA received a number of comments about proposed paragraph (b)(1). (See, for example, Exs. 0128, 0180, 0211, 0219, 0227, 0230.) Some of these comments generally supported the proposal, noting that there are no situations in which work covered by Subpart V would necessitate different requirements for fall arrest equipment than those already found in Subpart M. (See, for example, Exs. 0219, 0227, 0230.) Mr. Mark Spence with Dow Chemical Company supported the incorporation of subpart M in both subpart V and § 1910.269, but noted OSHA's plan to revise the general industry fall protection standard. He recommended that § 1910.269 and subpart V eventually be revised to refer to the updated general industry fall protection provisions:

> The existing general industry standard [§ 1910.269] requires personal fall arrest equipment to meet the requirements of the construction industry fall protection standards, 29 CFR Part 1926, Subpart M. Both § 1910.269 and Subpart M were promulgated in 1994, whereas the general industry fall protection standards date back to 1971 (and are based on earlier requirements). To take advantage of the updated fall protection requirements in the construction standards, OSHA chose to make them applicable to work under this general industry standard. [Footnote omitted.]
>
> * * * * *
>
> Dow sees no current option for OSHA other than continuing to refer to Subpart M, supplementing it as appropriate with new provisions, as OSHA has done here. However, Dow urges OSHA to proceed expeditiously with the issuance of . . . new general industry fall protection . . . standards. Once . . . new [general industry fall protection standards are] published as a final rule, OSHA should revise both [Subpart V and § 1910.269] to refer to the new [provisions]. [Ex. 0126]

On May 24, 2010, OSHA proposed to revise the general industry walking-working surfaces standards and the personal protective equipment standards (75 FR 28862). The proposal included a new standard for personal fall protection systems, § 1910.140, which would increase consistency between construction, maritime, and general industry standards. When that rulemaking is finalized, OSHA will consider whether the cross-references in subpart V and § 1910.269 should be changed as recommended by Mr. Spence.

Two commenters noted that subpart M does not address arc-flash resistance for fall arrest equipment and recommended that OSHA require this equipment to pass arc-flash tests (Exs. 0180, 0211). Mr. Daniel Shipp of ISEA supported arc-flash testing as follows:

> We believe that workers in electric power transmission and distribution have special requirements different from those in general construction activities. These special requirements are recognized as hazards associated with exposure to high-voltage electric current. The hazard of exposure to energized electrical sources often occurs at height[s] where personal fall arrest systems are required. The hazard of electric arc flash has been addressed in the ASTM F887–04 [*Standard Specifications for Personal Climbing Equipment*] for full body harnesses used in fall arrest.

[103] The term "fall restraint system" as defined in § 1926.751 is a broad term that includes travel-restricting equipment, tethering systems, and other systems that prevent an employee from falling any distance.

[104] See the discussion of the appendices to the final rule, later in this section of the preamble. As explained in the appendices, the referenced national consensus standards, including IEEE Std 1307, contain detailed specifications that employers may follow in complying with the more performance-oriented requirements of OSHA's final rule. However, compliance with IEEE Std 1307 is not a substitute for compliance with § 1926.954(b).

[105] IEEE Std 1307–2004 is the most recent edition of that consensus standard.

We support the inclusion of electric arc-flash resistance requirements, referenced in ASTM F887–04, to be extended to [include] fall arrest PPE, especially full body harnesses and shock absorbing lanyards that are worn together as part of a complete fall arrest system. These components would be exposed to potentially damaging thermal shock in the event of an arc flash. The damage to lanyards not designed to withstand a high-voltage arc flash can be quite severe, reducing strength to levels below the factor of safety necessary to assure arrest of a fall. Tests have been performed by the Kinetrics high energy laboratory on high-tensile webbing, such as that used in fall protection PPE products. Testing at exposure levels of 40 cal/cm², in accordance with the procedures in ASTM F1958/F1958M–99 [*Standard Test Method for Determining the Ignitability of Non-flame-Resistance Materials for Clothing by Electric Arc Exposure Method Using Mannequins*], demonstrated ignition and melting of the webbing sufficient to reduce webbing strength by greater than 30 percent.

One common example of this hazard involves employees tied off in bucket trucks working in close proximity to high-voltage power lines. The fall arrest harness and lanyard are typically exposed above the edge of the bucket where contact with electric arc flash is possible. In the event of an incident, including a fall by ejection out of the bucket, the strength of fall arrest components could be severely compromised if they were exposed to a high-voltage electric arc flash. [Ex. 0211]

Mr. Leo Muckerheide of Safety Consulting Services similarly recommended that harnesses and lanyards used by employees working on or near energized circuits meet ASTM F887–04, because that consensus standard provides performance criteria for arc resistance (Ex. 0180).

OSHA recognizes that employees performing work covered by subpart V and § 1910.269 are sometimes exposed to hazards posed by electric arcs. In fact, final §§ 1910.269(l)(8) and 1926.960(g) are designed to protect employees from electric arcs. In addition, the Agency already recognized the need for work-positioning equipment to be capable of passing a flammability test to ensure that the equipment does not fail if an electric arc occurs. (See final §§ 1910.269(g)(2)(iii)(G)(5) and 1926.954(b)(2)(vii)(E).) On the other hand, in work covered by subpart V or § 1910.269, personal fall arrest equipment has broader application than work-positioning equipment, with work-positioning equipment being used primarily on support structures for overhead power lines. Several applications for personal fall arrest equipment involve work that does not pose electric-arc hazards, especially in electric power generation work covered by § 1910.269. For example, an employee working on a cooling tower or atop a dam at an electric power generation plant would not normally be exposed to these hazards. Consequently, OSHA decided not to include a general requirement for all fall arrest equipment used under the final rule to be capable of passing an electric-arc test.

However, OSHA agrees that electric arcs can damage personal fall arrest equipment as readily as work-positioning equipment. The testing to which the commenters referred, and which is the basis of the test data found in the record, demonstrates that harnesses subjected to an electric arc can fail a drop test (Ex. 0432). The Agency concludes from these test data that personal fall arrest equipment worn by an employee who is exposed to an electric arc could fail if it is not designed to withstand the heat energy involved. OSHA also agrees with the commenters that employees working on or near energized circuits are exposed to electric arcs when the circuit parts are exposed (Ex. 0180). Accordingly, OSHA adopted a requirement in the final rule that fall arrest equipment used by employees exposed to hazards from flames or electric arcs be capable of passing a drop test after exposure to an electric arc [106] with a heat energy of 40±5 cal/cm². This requirement matches the electric arc performance required of fall arrest equipment by ASTM F887–04 (Ex. 0055). The provision appears in final paragraph (b)(1)(ii).

Paragraph (g)(1) of § 1926.960 in the final rule requires employers to identify employees exposed to the hazards of flames or electric arcs. When these employees are using personal fall arrest equipment, that equipment also would be exposed to flame or electric-arc hazards, and the final rule requires this fall arrest equipment to be capable of passing a drop test equivalent to the test specified in paragraph (b)(2)(xii) (discussed later in this section of the preamble) after exposure to an electric arc with a heat energy of 40±5 cal/cm². Harnesses and shock-absorbing lanyards meeting ASTM F887–12^{e1} [107] will be deemed to comply with this provision.

OSHA received a substantial number of comments addressing fall protection requirements for employees working in aerial lifts. Existing fall protection requirements to protect employees in aerial lifts performing work, including line-clearance tree-trimming work, covered by Subpart V or § 1910.269 are found in several standards. In construction, the construction aerial lift standard (§ 1926.453) and subpart M apply. For maintenance and operation work, the general industry aerial lift standard (§ 1910.67) and existing § 1910.269(g)(2) (incorporating subpart M of the construction standards) apply. Currently, line-clearance tree-trimming work is typically governed by the fall protection requirements in § 1910.269 and, depending on the type of work performed, falls under either the general industry or construction aerial lift standard.

Paragraph (b)(2)(v) of § 1926.453 in the construction standard for aerial lifts requires an employee working from an aerial lift to wear a body belt with a lanyard attached to the boom or basket. However, the introductory text to § 1926.502(d) in subpart M provides that "body belts are not acceptable as part of a personal fall arrest system." The hazards of using a body belt as part of a fall arrest system are described in the preamble to the Subpart M final rule (59 FR 40672, 40702–40703, Aug. 9, 1994) and later in this section of the preamble. In short, since the fall-arrest forces are more concentrated for a body belt compared to a body harness, the risk of injury in a fall is much greater with a body belt. In addition, an employee can fall out of a body belt in a fall. Lastly, an employee faces an unacceptable risk of further injury while suspended in a body belt awaiting rescue.

Given the potential discrepancy between the aerial lift standard's requirement for body belts and the subpart M limitation on the use of body belts in fall arrest systems, a note following § 1926.453(b)(2)(v) explains that § 1926.502(d) provides that body belts are not acceptable as part of a personal fall arrest system. The use of a body belt in a tethering system or in a restraint system is acceptable and is regulated under § 1926.502(e).

Like the aerial lift standard in construction, the general industry aerial lift standard at § 1910.67(c)(2)(v) requires an employee working from an aerial lift to wear a body belt with a lanyard attached to the boom or basket. Even though existing § 1910.269(g)(2)(i) requires fall arrest equipment to meet subpart M of part 1926, which prohibits the use of body belts in personal fall arrest systems, the Agency previously decided that employers could use body belts and lanyards configured as fall

[106] The electric arc test required by this paragraph is a test exposing the equipment to an electric arc with a specified incident heat energy. ASTM F887–12^{e1} includes an electric-arc test method that involves positioning the fall arrest equipment in front of two vertically mounted electrodes. The electric arc forms between the electrodes.

[107] The final rule is based on the edition of the consensus standard that is in the record, ASTM F887–04, *Standard Specifications for Personal Climbing Equipment* (Ex. 0055). OSHA reviewed the most recent edition of this standard, ASTM F887–12^{e1}, and found that equipment meeting that standard will also comply with final § 1926.954(b)(1)(ii).

arrest systems to protect employees doing work covered by § 1910.269 in aerial lifts.

OSHA explained in the preamble to the proposal that this rulemaking would prohibit the use of body belts in personal fall arrest systems for all work covered by § 1910.269 and subpart V, including work done from aerial lifts (70 FR 34850). The tree trimming industry criticized OSHA's proposed application of the Subpart M prohibition on body belts in personal fall arrest systems on the basis that it left line-clearance tree trimming employers with two (in the industry's view, undesirable) options—providing either (1) a personal fall arrest system with a body harness, or (2) a positioning system that, under proposed § 1926.954(b)(3)(iv) (or proposed § 1910.269(g)(2)(iii)(D)), is rigged to prevent free falls of more than 0.6 meters (2 feet). (See, for example, Exs. 0174, 0200, 0502, 0503; Tr. 611–619, 756–760.)

The tree trimming industry is mistaken about the compliance options available to its employers. The 0.6-meter free-fall limit applies only to work-positioning equipment, which may not be used in aerial lifts. As noted previously, under § 1926.500(b) of subpart M, "positioning device system" is defined as "a body belt or body harness system rigged to allow an employee to be supported on an elevated vertical surface, such as a wall, and work with both hands free while leaning." Positioning device systems are *not* permitted to be used from a horizontal surface, such as the platform or bucket of an aerial lift.[108]

Although employees in aerial lifts cannot use work-positioning equipment, they can use restraint systems. As noted previously, a restraint system is a method of fall protection that prevents the worker from falling, for example, by preventing the employee from reaching an unprotected edge. Body belts are permissible in restraint systems. If an employer has an employee use a fall restraint system, it must ensure that the lanyard and anchor are arranged so that the employee is not exposed to falling any distance.[109] In addition, for a restraint system to work, the anchorage must be strong enough to prevent the worker from moving past the point where the system is fully extended, including an appropriate safety factor. In a November 2, 1995, letter of interpretation to Mr. Dennis Gilmore, OSHA suggested that, at a minimum, a fall restraint system have the capacity to withstand at least 13.3 kilonewtons (3,000 pounds) or twice the maximum expected force that is needed to restrain the employee from exposure to the fall hazard.[110] The Agency recommended that, in determining this force, employers should consider site-specific factors such as the force generated by an employee (including his or her tools, equipment and materials) walking, slipping, tripping, leaning, or sliding along the work surface.[111] With respect to work in aerial lifts, to the extent that the bucket or platform can become separated from the boom as noted by several commenters (see, for example, Tr. 614–615, 700), the restraint system would need to be anchored to the boom.

The proposed rule gave line-clearance tree trimming employers two options for employees in aerial lifts: (1) Use a personal fall arrest system with a harness; or (2) use a fall restraint system with a body belt or a harness. With respect to the first option, the tree trimming industry argued that personal fall arrest systems with body harnesses pose two hazards unique to line-clearance tree trimmers: (1) An electrocution hazard in the event of a fall into a power line and (2) a hazard associated with a harness' being pulled into a chipper. (See, for example, Exs. 0174, 0200, 0502, 0503; Tr. 616–617, 757–758.) Testifying on behalf of ULCC, Mr. Andrew Salvadore explained these arguments as follows:

> It is to be noted that this full body harness as one of the options is potentially problematic though for line clearance tree trimmers. [D]ue to the unique way that line clearance tree trimmers work, this is for two reasons.
>
> Reason 1: Linemen work next to energized conductors at arm's height. So if they fall from the aerial lift, they fall below the wire suspended in the air. But because . . . line clearance tree trimmers uniquely work from aerial lifts routinely positioned . . . or traveling above the wires if they were to fall from the bucket, they would likely fall onto the wire below when using the six-foot lanyard and full body harness, facing certain death by electrocution.
>
> Reason 2: Some line clearance tree trimming companies have their tree trimmers help feed brush into the truck's wood chippers. This is a concern among many line clearance tree trimming safety professionals in that the harness's appendage straps . . . can get caught on the brush being fed into the chipper and drag the operator into the chipper. Additionally the donning and doffing of a full body harness may predispose the aerial lif[t] operator to take [an] unacceptable risk of aiding a coworker chipping brush on the ground or conversely removing the harness and not putting it back on when returning [aloft] in the lift. [Tr. 616–617]

In their posthearing comments, ULCC and TCIA expanded on this testimony. These organizations acknowledged that power line workers also work above power lines, but maintained that there are still significant differences that make it more dangerous to use personal fall arrest equipment with harnesses for line-clearance tree trimming work (Exs. 0502, 0503). First, ULCC and TCIA argued that, unlike line-clearance tree trimmers, line workers take measures to protect themselves from contact with power lines below the aerial lift bucket. For example, TCIA commented:

> Through questioning of IBEW Panelists Jim Tomaseski and Don Hartley (Hearing Transcript, pages 1016–1019), we discovered that it is the lineman's typical practice to insulate wires underneath the person in an elevated work position in an aerial lift when there is the possibility of the worker coming within (including falling within) the minimum approach distance. Obviously, it effectively frees the lineman from concern of their fall protection allowing them to drop into the conductor(s). [I]nsulating the line is infeasible or impractical for our crews since they do not possess the tools or expertise to implement it. [Ex. 0503]

Second, ULCC asserted that line workers perform significantly less work above power lines than line-clearance tree trimmers, explaining:

> Linemen usually work *at* the height of the electric line; their work from above the line is atypical—we estimate that less than 20% of linemen work is from above the line. Thus, the amount of linemen work [conducted] from above an electric line is di minimis [*sic*]. [Ex. 0502; emphasis included in original]

First, with respect to fall arrest equipment, OSHA does not consider body harnesses to pose greater hazards to line-clearance tree trimmers than

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[108] See, for example, the following OSHA letters of interpretation:

May 11, 2001, to Mr. Jessie L. Simmons (*http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=24360*);

August 14, 2000, to Mr. Charles E. Hill (*http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=24110*); and

April 20, 1998, to Mr. Jonathan Hemenway Glazier (*http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=22569*).

[109] See, for example, the August 14, 2000, letter of interpretation to Mr. Charles E. Hill (*http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=24110*).

[110] This letter of interpretation is available at (*http://osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=22006*.

[111] See also the following letters of interpretation:

November 8, 2002, to Mr. Jeff Baum (*http://osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=24576*); and

November 2, 1995, to Mr. Mike Amen (*http://osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=21999*).

body belts. The hazard to a worker from being pulled into a chipper is easily dismissed. OSHA acknowledges that there are serious hazards associated with operating chippers, including the hazard that workers could be caught by the chipper feed mechanism. NIOSH published an article warning of hazards associated with the operation of chippers (see NIOSH Publication No. 99–145, "Hazard ID 8—Injury Associated with Working Near or Operating Wood Chippers;" Ex. 0481), and that publication provides recommendations to protect workers against being caught in the feed mechanism.[112] These recommendations include: (1) Having workers wear close-fitting clothing and gloves, (2) having workers wear trousers without cuffs, and (3) ensuring that employees tuck in their clothing. Consistent with these recommendations, OSHA expects that any hazards associated with using a chipper while wearing a harness can be avoided by requiring employees to remove their harnesses before working with the chipper. The tree trimming industry commented that employees might not want to take off their harnesses before feeding brush into chippers. (See, for example, Ex. 0502; Tr. 616–617.) OSHA does not find that argument persuasive. Employers can avoid this concern altogether by having these workers perform other ground-based work, such as moving the cut tree branches near the chipper, while ground workers, who are not wearing harnesses, feed the branches into the chippers.

Second, OSHA does not consider the risk of falling into a power line to be as serious as the tree care industry portrays. If an employee falls from an aerial lift while using a personal fall arrest system with a harness, contact with a power line, though possible, is not certain. Sometimes the employee will not be working over the line. In other situations, the line will be on one side of the aerial lift bucket, but the employee will fall out on the other side where no conductors are present. In addition, the line may be far enough away that the employee does not reach it during the fall. In any event, the hazards associated with an employee falling into a power line can be reduced—or even removed altogether—by using a shorter lanyard as suggested by some rulemaking participants. (See, for example, Ex. 0505; Tr. 694–695.) In this regard, IBEW noted: "If . . . the normal lanyard length [for a fall arrest system] of 5 to 6 feet is too long, the lanyard can be shortened to 3 or 4 feet, thereby eliminating the anticipated problems" (Ex. 0505). Noting that the attachment point on a harness will be farther from the anchorage on the boom than is the attachment point on a body belt, ULCC claimed that a 0.9-meter (3-foot) lanyard was unworkable with a body harness (Ex. 0502). OSHA is not suggesting that a 0.9-meter lanyard with a body harness is feasible, only that a lanyard shorter than 1.8 meters (6 feet) could be used to reduce the risk of contact with a power line. A retractable lanyard could be used to keep the length of the lanyard as short as possible, thereby reducing the risk even further.

Finally, the tree trimming associations' attempt to portray the hazards of falling into power lines as unique to their industry is flawed. The evidence is clear from the comments of employees who perform line work that power line workers also work above power lines and can fall into them. (See, for example, Ex. 0505; Tr. 971.) In addition, ULCC's attempt to distinguish line-clearance tree trimming work from power line work on the grounds that power line workers insulate the conductors above which they are working is unpersuasive. Like line-clearance tree trimmers, power line workers often work above energized power lines that have not been insulated. The final rule does not require insulation on conductors for a power line worker maintaining the minimum approach distance. In addition, insulating the lines is not always possible. According to § 1926.97(c)(2)(i) and Table E–4 of the final rule, the highest maximum use voltage for rubber insulating equipment, such as rubber insulating line hose or blankets, is 36 kilovolts. The maximum use voltage for plastic guard equipment is 72.5 kilovolts (Ex. 0073). Insulation is not available above those voltages.

TCIA argued that insulating power lines is not feasible or practical for line-clearance tree trimming crews (Ex. 0503). OSHA is not persuaded by this argument. To the extent that it is the practice of line workers to insulate conductors beneath them, OSHA concludes that this practice also represents a feasible means of protecting line-clearance tree trimmers from the hazard of falling into the line. The comment that line-clearance tree trimmers are not currently being trained in this practice is not relevant to whether it is feasible. If necessary, a line-clearance tree trimming employer could have the electric utility install the insulation or train line-clearance tree trimmers so that they are qualified to install insulation. In any event, the final rule does not require insulation for line-clearance tree trimmers; the final rule at § 1910.269(r)(1)(iii) simply requires them to maintain the minimum approach distance from power lines. The use of insulation would simply be one way for line-clearance tree trimming employers to address their concern about employees falling into power lines while using personal fall arrest systems.

The tree trimming industry did not submit any comments directly addressing the use of restraint systems, which is the second compliance option available to line-clearance tree trimming employers. Instead, as a result of the industry's misunderstanding regarding the applicability of the 0.6-meter (2-foot) free-fall distance for work-positioning systems (described earlier), it simply argued that it would be impossible or unsafe for employees working from an aerial lift to use a 0.6-meter lanyard with a body belt for their work. (See, for example, Exs. 0174, 0200, 0419, 0502, 0503; Tr. 613–615, 756.)

Mr. Andrew Salvadore, representing ULCC, testified as follows:

> [W]e can't do line clearance tree trimming with a lanyard of two foot [*sic*] or less. There are three reasons for this.
>
> Reason No. 1: Line clearance tree trimmers need to be able to reach from the four corners of an aerial lift bucket to do their work because [of the need] to maintain a minimum approach distance from energized wires different from linemen who can work right next to the wires. We can't get to the four corners of the bucket with a two-foot or shorter lanyard, typically anchored . . . outside of the bucket on the boom. This prevents us from reaching outside of the bucket with our tools or extending from the bucket. . . .
>
> Reason 2: The two-foot limitation is also unworkable because we usually work from [an] aerial lift positioned above energized conductors, reaching down to the tree branches below adjacent to conductors using insulated pole tools. This is different from linemen who typically position their lift buckets right next to the wire at arm's length. We lack the range of movement within the bucket necessary to reach over the bucket and down to the worksite because we would be restrained to the side of the bucket closest to the anchor. Relocation of an anchor is not [an] easy fix because the anchor is required to withstand a 5,000 pounds of force and typically can't be installed on the bucket . . . because [of] the lack of [a] strong enough anchoring point and because if the bucket breaks off in a catastrophic incident the worker goes down with the anchor attached to the bucket [rather than] being suspended by the lanyard attached to the boom.
>
> The Third Reason: Our people may be potentially yanked out of the bucket into precisely the fall that is sought to be avoided by the proposal because line clearance tree trimmers routinely rotate and articulate their lift buckets in ways that would exceed the distance of a short lanyard. . . . [This

[112] This document is available at *http://www.cdc.gov/niosh/docs/99–145.*

exposes] the worker to being yanked out of the bucket by the short lanyard when the range of articulation of the bucket exceeds the short length of the lanyard. [Tr. 613–615]

To address these problems, the tree care industry recommended that OSHA permit the use of a 0.9-meter (3-foot) shock-absorbing lanyard with a body belt. (See, for example, Exs. 0174, 0200, 0502, 0503; Tr. 615—616, 759—760.) The industry proposed a 408-kilogram (900-pound) limitation on fall arrest forces, presumably to remove hazards associated with concentrated fall arrest forces in falls into body belts (*id.*).

As noted earlier, the tree care industry misinterpreted its compliance options under the proposed rule. For work from an aerial lift, there are only two options: (1) Fall arrest equipment and (2) a fall restraint system. Restraint systems do not permit any free fall. An acceptable restraint system for an aerial lift would prevent an employee from falling out of the lift and from being catapulted from the lift (for example, if the vehicle supporting the aerial lift was struck by a vehicle or if a large tree section struck the boom). Body belts are permitted as part of a restraint system; however, a system rigged to allow an employee to free fall even 0.6 meters (2 feet) would not be acceptable as a restraint system. The system proposed by the tree care industry, namely a body belt connected to a 0.9-meter (3-foot) lanyard attached to an anchorage on the boom of an aerial lift, would not prevent the employee from falling out of or being catapulted from an aerial lift. Therefore, it would not be acceptable as a restraint system.

Moreover, with a body belt instead of a harness, the system proposed by the tree care industry would not be an acceptable fall arrest system. Even if it provides sufficient protection to employees against concentrated fall arrest forces, it does not address the other two significant hazards associated with falling into body belts, that is, falling out of the body belt and sustaining further injury during suspension.[113]

The tree care industry asserted that OSHA has not demonstrated that using body belts in personal fall arrest systems in aerial lifts poses hazards to line-clearance tree trimmers. (See, for example, Exs. 0174, 0200, 0502, 0503; Tr. 613, 758–759.) TCIA made this point as follows:

> The only fall protection issue arising in aerial lifts is failure to use *any* form of fall protection—an unsafe and non-compliant behavior that the industry must strive to eliminate. Similarly, if operators in the past have worn body belts incorrectly, causing the equipment to not deliver the level of protection it should have, then there is a behavioral issue to address in training.
>
> It is our industry's experience that workers are not being injured by virtue of using body belts . . . and that non-compliance with PPE use requirements is directly proportional to how hard or uncomfortable the PPE is to use. [Ex. 0200; emphasis included in original]

ULCC had similar comments:

> Preliminarily, there is NO showing in the subject notice of rule making that . . . allowing a body belt and lanyard for fall protection from aerial devices . . . creates a risk which merits modification of existing practice. It is our industry's experience that line clearance tree trimmers are *not* being injured by virtue of using body belts (OSHA cites no evidence, nor contrary evidence of any such bucket fall hazard or hazard from body belt lanyards over two feet long in line clearance tree trimming), and that lack of compliance with PPE use requirements is directly proportional to how hard or uncomfortable the PPE is to use. Between 1984 and 2002, there were 34 OSHA-recorded fatalities in Tree Trimming (SIC 0783) involving aerial device operators and falls. The details of these accidents illustrate where the greatest problems lie:
>
> • 23 of 34 fatalities were caused by catastrophic mechanical failures of some part of the aerial device that slammed the victim to the ground from considerable height. Fall protection, or lack of it, was not a factor in these fatalities.
>
> • 5 of 34 fatalities were caused by a tree or limb striking the aerial lift boom, again causing failure of the aerial device. Again, fall protection was not a factor.
>
> • 6 of 34 fatalities were caused by *unsecured* falls from the aerial device, and probably would have been prevented by the use of *any* means of fall protection.
>
> At a recent meeting of the Tree Care Industry Association Safety Committee (a tree care industry trade association), with the safety directors of 20 of the largest tree care companies representing well over 60,000 tree care employees present, a survey was taken as to whether these companies had any experience with aerial lift operators being injured from secured falls out of buckets. *None did.* For them, *the more profound problem was the operator who disobeyed company policy and failed to wear any fall protection.* [Ex. 0174; emphasis included in original]

In its posthearing comments, ULCC further argued that the one accident OSHA described, in which an employee slipped out of a body belt, occurred to a line worker, not a line-clearance tree trimmer, and that this single accident "is statistically insignificant, insufficiently documented on the record, and in no way probative of any problem of line clearance tree trimmers falling from aerial lifts" (Ex. 0502). ULCC further suggested that OSHA's proposal ignored the suspension-trauma risk associated with full body harnesses (Exs. 0481, 0502). (OSHA describes the hazards related to prolonged suspension in fall protection equipment later in this section of the preamble.)

OSHA rejects these assertions. OSHA closely examined issues related to the use of body belts in arresting falls in its Subpart M rulemaking (59 FR 40702–40703). In that rulemaking, the Agency concluded that "evidence in the record clearly demonstrates that employees who fall while wearing a body belt are not afforded the level of protection they would be if the fall occurred while the employee was wearing a full body harness" (59 FR 40703). In addition, the Agency pointed to "evidence of injuries resulting from the use of body belts" in fall arrest systems (*id.*). Also, as mentioned by ULCC, there is evidence in this rulemaking of an incident in which an employee, working from an aerial lift while wearing a body belt in a fall arrest system, slipped from the belt in a fall (Ex. 0003[114]). Contrary to the tree care industry's suggestion, OSHA need not show that injuries are presently occurring to line-clearance tree trimmers because of falls into body belts; it is sufficient that the Agency found that tree trimming employees are exposed to a significant risk of injury under the existing standard and that the final rule will substantially reduce that risk. (See Section II.D, Significant Risk and Reduction in Risk, earlier in this preamble, for OSHA's response to the argument that the Agency is required to demonstrate a significant risk for each of the hazards addressed by this rulemaking.) ULCC's own analysis confirms that line-clearance tree trimmers are exposed to fall hazards (Ex. 0174). Nearly 18 percent of falls from aerial lifts were of the type that, if the employee had been wearing a body belt in a personal fall arrest system, he or she would have been exposed to the serious hazards, described earlier, that

[113] Paragraph (d)(16) of § 1926.502 requires a personal fall arrest system to be rigged so that the employee cannot free fall more than 6 feet (1.8 meters) nor contact any lower level. The Agency notes that the lanyard may need to be shorter than the maximum free-fall distance. This is the case for aerial lift work. The anchorage point on the boom of an aerial lift may be below the attachment point on the body belt or harness. As a result, the employee could free fall a distance equal to twice the length of the lanyard if he or she is ejected or catapulted from the aerial lift, as can happen when a vehicle strikes the aerial lift truck or a falling object, such as a tree branch, strikes the boom. This is not an unlikely event as several accidents in the record demonstrate (Ex. 0003; these three accidents can be viewed at *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=14507743&id=953869&id=14333157*). Thus, the tree industry's recommended lanyard length could result in a free fall of 1.8 meters (6 feet).

[114] The description of this accident is available at: *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=170155857.*

are associated with using body belts in fall arrest systems (*id.*).

The Agency acknowledges the suspension risk from body harnesses identified by ULCC. When an employee is suspended in a body belt or harness, a number of adverse medical effects can occur, including upper or lower extremity numbness; abdominal, shoulder, or groin pain; respiratory distress; nausea; dizziness; and arrhythmias (Ex. 0088). At least one of the adverse effects, orthostatic incompetence, can lead to death (Ex. 0481). It is because of these hazards that § 1926.502(d)(20) in Subpart M requires the employer to provide for prompt rescue of employees in the event of a fall or to assure that employees are able to rescue themselves. In any event, the hazards associated with prolonged suspension in a body belt are substantially more severe than the hazards associated with suspension in a harness. In 1985, the U.S. Technical Advisory Group on Personal Equipment for Protection Against Falling stated, in comments on another OSHA rulemaking: "The length of time which a fallen person can tolerate suspension in a body belt is measured in a very few minutes under the most favorable conditions" (Ex. 0084). In addition, a 1984 U.S. Air Force literature review recounted one study that found that "two subjects evaluated in . . . waist belt[s] with shoulder straps tolerated suspension for 1 min 21 sec and 3 min" (Ex. 0088).[115] That same study showed that subjects suspended in full body harnesses could tolerate suspension for approximately 20 to 30 minutes (*id.*).

The tree care industry commented that, to the extent injuries are occurring, they are caused by the failure of employees to use any fall protection, rather than by the use of body belts. (See, for example, Exs. 0174, 0200.) This argument supports, rather than undermines, a requirement for harnesses in personal fall arrest systems. To the extent better enforcement of fall protection requirements by employers is a critical component of protecting employees in aerial lifts, harnesses are preferable to body belts. It is not always possible to detect from the ground whether an employee is wearing a body belt, but it is relatively easy to determine if an employee is wearing a body harness (Tr. 972–973). If employees initially resist the use of body harnesses, as suggested by some commenters (see, for example, Exs. 0174, 0200, 0219), employers must be proactive in communicating the need for, and ensuring the use of, the required equipment.

The Agency concludes that the use of a 0.9-meter shock-absorbing lanyard with a body belt, as proposed by the tree trimming industry, is not an adequate substitute for the use of a harness in a fall arrest system. OSHA has not been persuaded to abandon its finding in the Subpart M rulemaking that body belts present unacceptable risks in fall arrest situations and should be prohibited as components of fall arrest equipment. OSHA is adopting in the final rule the requirement proposed in paragraph (b)(1) that personal fall arrest equipment meet Subpart M of Part 1926. This provision appears in final § 1926.954(b)(1)(i).

ULCC noted what it perceived as an implied, but unstated, revision in the proposal to the provisions contained in the general industry aerial lift standard (§ 1910.67(c)(2)(v)) requiring employees working in aerial lifts to use body belts and lanyards. (See, for example, Ex. 0174.)

In the preamble to the proposal, OSHA explained that it was relying on the provisions in the aerial lift standards to establish the employer's duty to provide fall protection for employees, but that Subpart M would govern the criteria fall arrest equipment must meet (70 FR 34850). In other words, for work covered by this rule, body belts would not be permitted in personal fall arrest systems. The ULCC commented: "OSHA's suggestion that [the aerial lift standard] describes only the 'duty' to use fall protection rather than the kind of fall protection, respectfully, is a makeweight" (Ex. 0502).

In light of ULCC's comments, the Agency is concerned that some employers reading the final rule may mistakenly assume that the body belts required by §§ 1910.67(c)(2)(v) and 1926.453(b)(2)(v) remain acceptable for use in personal fall arrest systems. In addition, the Agency wants to make it clear in the final rule that work-positioning equipment is unacceptable from the horizontal working surface of an aerial lift. Employees working from aerial lifts covered by the final rule must be protected using either a fall restraint system or a personal fall arrest system. Therefore, OSHA is adding a provision in final §§ 1910.269(g)(2)(iv)(C)(1) and 1926.954(b)(3)(iii)(A) providing that employees working from aerial lifts be protected with a fall restraint system or a personal fall arrest system and that the provisions of the aerial lift standards requiring the use of body belts and lanyards do not apply. This provision clearly states the requirement contained in the proposal. As a consequence of this change, the final rule does not include the text in Note 1 to proposed § 1910.269(g)(2)(iii)(C) and Note 1 to proposed § 1926.954(b)(3)(iii) referring to fall protection for aerial lifts or referencing the general industry and construction standards on aerial lifts. (The corresponding notes in the final rule are Note 1 to § 1910.269(g)(2)(iv)(C)(2) and (g)(2)(iv)(C)(3) and Note 1 to § 1926.954(b)(3)(iii)(B) and (b)(3)(iii)(C).)

OSHA is adopting revised requirements for work-positioning equipment in § 1926.954(b)(2).[116] Section 1926.959 of existing Subpart V contains requirements for body belts, safety straps,[117] and lanyards.[118] This equipment was traditionally used as both work-positioning equipment and fall arrest equipment in the maintenance and construction of electric power transmission and distribution installations. However, fall arrest equipment and work-positioning equipment present significant differences in the way they are used and in the forces they place on an employee's body. With fall arrest equipment, an employee has freedom of movement within an area restricted by the length of the lanyard or other device connecting the employee to the anchorage. In contrast, and as explained earlier, work-positioning equipment is used on a vertical surface to support an employee in position while he or she works. The employee "leans" into this equipment so that he or she can work with both hands free. If a fall occurs while an employee is wearing fall arrest equipment, the employee will free fall up to 1.8 meters (6 feet) before the slack is removed and the equipment begins to arrest the fall. In this case, the fall arrest forces can be high, and they need to be spread over a relatively large area of the

[115] Hearon, B.F., Brinkley, J.W., "Fall Arrest and Post-Fall Suspension: Literature Review and Directions for Further Research," AFAMRL–TR–84–021, April 1984.

[116] In § 1910.269(g)(2)(ii), OSHA proposed to require body belts and positioning straps for work positioning to meet § 1926.954(b)(2). The final rule duplicates the requirements of § 1926.954(b)(2) in § 1910.269(g)(2)(iii) rather than referencing them.

[117] "Safety straps" is an older, deprecated term for "positioning straps."

[118] Existing § 1926.500(a)(3)(iii) states that additional performance requirements for personal climbing equipment, lineman's body belts, safety straps, and lanyards are provided in subpart V. OSHA is revising the language in this provision to make it consistent with the terms used in final Subpart V. Furthermore, because the Agency is adopting, in subpart V, an additional requirement for fall arrest equipment used by employees exposed to electric arcs (as described earlier in this section of the preamble), OSHA is adding fall arrest equipment to the list of equipment in § 1926.500(a)(3)(iii). As revised, § 1926.500(a)(3)(iii) states that additional performance requirements for fall arrest and work-positioning equipment are provided in Subpart V.

body to avoid injury to the employee. Additionally, the velocity at which an employee falls can reach up to 6.1 meters per second (20 feet per second). Work-positioning equipment is normally used to prevent a fall from occurring in the first place. If the employee slips and if the work-positioning equipment is anchored, the employee will only fall a short distance (no more than 0.6 meters (2 feet) under paragraph (b)(3)(iv) of final § 1926.954). This distance limits the forces on the employee and the maximum velocity of a fall. Additionally, because of the way the equipment is used, the employee should not be free falling. Instead, the work-positioning equipment will be exerting some force on the employee to stop the fall, thereby further limiting the maximum force and velocity. As long as the employee is working on a vertical surface, the chance of an employee using work-positioning equipment falling out of, or being suspended at the waist in, a body belt is extremely low.

In the final rule, OSHA is applying requirements to personal fall arrest systems that differ from the requirements that apply to work-positioning equipment. As discussed previously, personal fall arrest systems must meet subpart M of part 1926, as required by paragraph (b)(1)(i), supplemented by the requirement in final paragraph (b)(1)(ii) that the equipment withstand exposure to electric arcs. Work-positioning equipment must meet the requirements contained in paragraph (b)(2) of the final rule. Employers engaged in electric power transmission and distribution work may use the same equipment for fall arrest and for work positioning provided the equipment meets both sets of requirements. In fact, as noted in the preamble to the proposal, several manufacturers market combination body harness-body belt equipment, which can be used as fall arrest systems by employees working on horizontal surfaces or as work-positioning systems supporting employees working on vertical surfaces (70 FR 34850).

Paragraph (b)(2) of the final rule is based on existing § 1926.959 and ASTM F887–04, *Standard Specifications for Personal Climbing Equipment,* which was the latest edition of the national consensus standard applicable to work-positioning equipment when OSHA developed the proposed rule (Ex. 0055). Although OSHA is adopting requirements derived from the ASTM standard, the final rule is written in performance-oriented terms. Detailed specifications contained in the ASTM standard, which do not directly impact the safety of employees, were not included in the final rule. The Agency believes that this approach will retain the protection for employees afforded by the ASTM standard, while giving employers flexibility in meeting the OSHA standard and accommodating future changes in the ASTM standard without needing to change the OSHA standard. This is similar to the approach OSHA took in final § 1926.97, discussed previously.

While the ASTM standard does not cover lanyards, paragraph (b)(2), as proposed, would have applied many of the requirements based on the ASTM standard to lanyards. Existing § 1926.959 imposes the same basic requirements on lanyards.

OSHA requested comment on whether any of the proposed requirements for work-positioning equipment should not be applicable to lanyards. Some commenters supported the Agency's proposal. (See, for example, Exs. 0211, 0230.) For instance, IBEW stated:

> [L]anyards used for fall protection for electric power transmission and distribution work [already] meet the requirements of ASTM F887–04. Therefore these requirements, as proposed, should be applicable to lanyards used for work positioning equipment. [Ex. 0230]

However, Buckingham Manufacturing Company, a manufacturer of work-positioning equipment used by line workers, opposed the application of some of the proposed requirements for work-positioning equipment to lanyards:

> Buckingham Mfg. recommends including a section on lanyards to remove requirements outlined in the referenced sections that are not applicable to lanyards such as: (b)(2)(vii) and including at least criteria such as strength requirements for the rope or webbing used to manufacture . . . a lanyard, the minimum number of rope tucks for rope lanyards, the length of stitching for turnover at ends of web lanyards, stitching used be of a contrasting color to facilitate visual inspection, etc. [Ex. 0199]

ASTM F887–04 refers to the straps used with work-positioning equipment as "positioning straps," not lanyards.[119] That consensus standard uses the term "lanyard" only with respect to personal fall arrest equipment. In addition, subpart M uses the term "lanyard" only in the requirements applicable to personal fall arrest systems in § 1926.502(d). However, existing § 1926.959 applies to "body belts, safety straps, and lanyards" used for either work positioning *or* fall arrest. Because the term "lanyard" is most typically used with reference to fall arrest equipment, OSHA is concerned that using that term in requirements for work-positioning equipment could lead employers or employees to believe that work-positioning equipment is acceptable for use in fall arrest situations, for example, when an employee is working from a horizontal surface. For these reasons, OSHA decided to use the term "positioning strap" instead of lanyard in final paragraph (b)(2) to describe the strap used to connect a body belt to an anchorage in work-positioning equipment. Thus, any strap used with work-positioning equipment is a "positioning strap" for the purposes of paragraph (b)(2). This language also should address Buckingham Manufacturing's concerns that some of the proposed requirements were inapplicable to lanyards. The Agency believes that Buckingham Manufacturing's comment was referring to lanyards used with personal fall arrest systems, which OSHA recognizes may not meet all of the requirements for positioning straps in final § 1926.954(b)(2). Paragraph (b)(2)(vii) contains specifications for positioning straps that are essential to electric power generation, transmission, and distribution work, including requirements for electrical performance, strength, and flame resistance (Ex. 0055). Lanyards, which are used with personal fall arrest systems, have to meet appropriate strength and, if necessary, arc-resistance requirements under subpart M and final § 1926.954(b)(1)(ii).

Paragraph (b)(2)(i), which is being adopted without substantive change from the proposal, requires hardware for body belts and positioning straps to be made from drop-forged steel, pressed steel, formed steel, or equivalent material. This hardware also must have a corrosion-resistant finish. Surfaces must be smooth and free of sharp edges. These requirements ensure that the hardware is durable, strong enough to withstand the forces likely to be imposed, and free of sharp edges that could damage other parts of the work-positioning equipment. These requirements are equivalent to existing § 1926.959(a)(1), except that the existing standard does not permit hardware to be made of any material other than drop-forged or pressed steel. Although ASTM F887–04 requires hardware to be made

[119] ASTM F887–12^{e1} uses the term "adjustable positioning lanyards" for equipment used as part of certain positioning devices. OSHA treats these lanyards as "positioning straps" under the final rule.

of drop-forged steel,[120] OSHA explained in the preamble to the proposal that, while the drop-forged steel process produces hardware that more uniformly meets the required strength criteria and will retain its strength over a longer period than pressed or formed steel, it is possible for other processes to produce hardware that is equivalent in terms of strength and durability (70 FR 34851). Paragraphs (d)(1) and (e)(3) of § 1926.502 already permit "connectors" (that is, "hardware" as that term is used in this final rule) to be made of materials other than drop-forged or pressed steel.

OSHA invited comments on whether alternative materials would provide adequate safety to employees. Most commenters responding to this issue supported the proposed language accepting the use of equivalent materials. (See, for example, Exs. 0126, 0162, 0173, 0175, 0186, 0230.) For instance, Ms. Salud Layton of the Virginia, Maryland & Delaware Association of Electric Cooperatives commented:

> We support the flexibility OSHA [is] offering in this area. Allowing hardware to be made of material other than drop-forged or pressed steel allows for potential alternatives to be evaluated for use. Other material, however, must meet the strength and durability criteria of drop-forged or pressed steel materials. [Ex. 0175]

Other commenters supported the proposal because it would permit the use of alternative materials that might be developed in the future (Exs. 0162, 0186, 0230). Mr. Daniel Shipp with ISEA commented that the "use of non-ferrous materials, including high-tensile aluminum with [a] protective anodize coating, is common" and noted that there are "criteria [available] for evaluating the equivalence between forged alloy steel and other materials" (Ex. 0211).

Although OSHA received no outright opposition to the proposal, ASTM Committee F18 on Electrical Protective Equipment for Workers, the committee responsible for developing ASTM F887, submitted the following statement from Mr. Hans Nichols, P.E., Metallurgical Consulting:

> My opinion is that forgings are superior to stampings. The principal advantage of forgings is control of grain direction to match the part geometry. The grain direction of a stamping will be oriented transverse to the part in some areas. Since the mechanical properties, i.e.—yield strength and impact strength, are lower in the transverse direction, this area of the part would be a weak point. [Ex. 0148]

OSHA agrees that some materials have advantages over others and expects that manufacturers typically base their design decisions on factors such as these. However, the fact that forgings may result in more uniform strength throughout a material than stampings is not relevant to the overall strength of hardware. It is the area of least strength that determines whether hardware has sufficient overall strength, and the design-test requirements in the final rule (discussed later in this section of the preamble) ensure that hardware, and the entire work-positioning system, are sufficiently strong. In other words, the testing requirements in the rule ensure that the weakest part of the weakest piece of the system will not fail under conditions likely to be encountered during use. In addition, the final rule requires that the hardware be made of material that has strength and durability equivalent to that of drop-forged, pressed, or formed steel, materials used successfully for work-positioning equipment for decades. Therefore, OSHA is including paragraph (b)(2)(i) in the final rule substantially as proposed.

Paragraph (b)(2)(ii), which is being adopted without substantive change from the proposal, requires buckles to 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). This requirement, which also can be found in existing § 1926.959(a)(2), will ensure that buckles do not fail if a fall occurs.

Paragraph (b)(2)(iii), which is being adopted without substantive change from the proposal, requires that D rings be capable of withstanding a 22-kilonewton (5,000-pound-force) tensile test without cracking or breaking. (A D ring is a metal ring in the shape of a "D." See Figure 2, which shows a snaphook and a D ring.) This provision, which is equivalent to existing § 1926.959(a)(3), will ensure that D rings do not fail if a fall occurs.

Paragraph (b)(2)(iv), which is being adopted without substantive change from the proposal, is equivalent to existing § 1926.959(a)(4) and requires snaphooks to be capable of withstanding a 22-kilonewton (5,000-pound-force) tension test without failure. A note following this provision indicates that distortion of the snaphook sufficient to release the keeper is considered to be tensile failure. The language of the note in the final rule was revised from the proposal to make it clear that such distortion is only one form of failure. The snaphook breaking completely is a more obvious failure not mentioned in the note.

Paragraph (b)(2)(v), which is being adopted without change from the proposal, prohibits leather or leather substitutes from being used alone as a load-bearing component of a body-belt and positioning-strap assembly. This is a new requirement for Subpart V and was derived from ASTM F887–04, Sections 14.2.1 and 15.2.1.[121] The requirement is necessary because leather and leather substitutes do not retain their strength as they age. Because this loss in strength is not always easy to detect by visual inspection, it can lead to failure under fall conditions.

Paragraph (b)(2)(vi), which is being adopted without substantive change from the proposal, requires that plied fabric used in positioning straps and in load-bearing portions of body belts be constructed so that no raw edges are exposed and the plies do not separate. This new requirement, which also is based on ASTM F887–04, in this instance, Sections 14.2.2 and 15.2.2, will prevent plied fabric from separating, which could cause it to fail under fall conditions.[122]

Although work-positioning equipment used in electric power transmission and distribution work is not to be used as insulation from live parts, positioning straps could come into accidental contact with live parts while an employee is working. Thus, OSHA deems it important for this equipment to provide a specified level of insulation. Accordingly, the Agency proposed, in paragraphs (b)(2)(vii)(A) and (b)(2)(vii)(B), to require positioning straps to be capable of passing dielectric and leakage current tests.[123] Similar requirements are found in existing § 1926.959(b)(1). The voltages listed in the proposed paragraphs were alternating current. A note following proposed paragraph (b)(2)(vii)(B) indicated that equivalent direct current tests also would be acceptable.

In the preamble to the proposed rule, OSHA explained that ASTM F887–04 did not require positioning straps to pass a withstand-voltage test (70 FR

[120] The current edition of this standard, ASTM F887–12^{e1}, also requires hardware to be made from drop-forged steel in Section 15.4.1.1.

[121] These requirements are also contained in the latest edition, ASTM F887–12^{e1}, in Sections 14.2.1 and 15.2.1.1.

[122] These requirements are also contained in the latest edition, ASTM F887–12^{e1}, in Sections 14.2.2 and 15.2.1.2.

[123] The dielectric and leakage-current tests required by these paragraphs involve attaching electrodes to the fall protection equipment, applying a test voltage across the electrodes, and checking for deterioration (in the case of the dielectric test) or measuring leakage current (in the case of the leakage-current test). ASTM F887–12^{e1} includes test methods for these two tests.

34851). Instead, the consensus standard stated in a note that the fabric used in the positioning straps must pass a withstand-voltage test. The Agency invited comment on whether performing electrical tests on positioning straps is necessary for employee safety in electric transmission and distribution work (that is, whether the requirements proposed in paragraphs (b)(2)(vii)(A) and (b)(2)(vii)(B) were necessary).[124] A number of commenters responded to this question. Some commenters supported OSHA's proposal. (See, for example, Exs. 0148, 0230.) For instance, IBEW explained:

> Positioning straps should offer a minimum level of insulation in the event [the] strap comes in contact with energized parts. The manufacturing specifications from ASTM F887–04 do not ensure the positioning strap actually offers any level of insulation. As stated in the proposal, the ASTM requirements only require the fabric used to make the strap be tested for leakage current. Other products used [in] the manufacture of the strap could . . . jeopardize the electrical [insulation] integrity of the fabric. Therefore, the leakage current of the finished product will not be known without a separate test. [Ex. 0230]

ASTM commented that "requirements in ASTM F887 04 for leakage current and withstand testing of the positioning strap material in Sections 15.3.1 and 15.3.1—Note 2 are adequate for the performance of the positioning strap" (Ex. 0148). The organization recommended that the ASTM language "be repeated in the Final 1926.954, or incorporated by reference" (*id.*).

Other commenters did not see a need to perform electrical tests on positioning straps. (See, for example, Exs. 0162, 0173, 0186, 0219.) For instance, Mr. Anthony Ahern with Ohio Rural Electric Cooperatives argued: "Given the environment these devices will be used in, within 5 minutes of being used the first time they will probably have enough dirt and wood preservative ground into them that they couldn't pass such a test again" (Ex. 0186). He also noted that this equipment has been in service for years and he is not aware of any accidents that have occurred due to the breakdown of a positioning strap (*id.*). Mr. Allen Oracion with Energy United EMC maintained that positioning straps will be separated from energized parts by at least the minimum approach distance, making withstand tests unnecessary (Ex. 0219).

OSHA believes that requiring positioning straps to be capable of passing the electrical tests in proposed § 1926.954(b)(2)(vii)(A) and (b)(2)(vii)(B) will provide an additional measure of protection to employees if a conductor or other energized part slips and lands on the strap or if the strap slips from the employee's hand and lands on an energized part. In response to Mr. Oracion's comment, the Agency notes that the minimum approach distance will not always protect employees exposed to electric-shock hazards. For example, minimum approach distances do not apply to conductors on which work is being performed by employees using rubber insulating gloves (as explained under the discussion of § 1926.960(c)(1) of the final rule). The proposed withstand- and leakage-testing requirements will confirm that the fabric used in the manufacture of the strap will provide insulation from electrical contact and that the manufacturing process that created the strap did not compromise the fabric's insulating properties. Although the equipment may become contaminated during use, as noted by Mr. Ahern, the inspection requirements in § 1926.954(b)(3)(i) of the final rule (discussed later in this section of the preamble) will ensure that any contamination that can affect the insulating properties of the equipment will be identified and removed. In addition, any contamination will normally be on the portion of the positioning strap in contact with a pole; the remaining portion of the strap will still provide a measure of protection.

The testing requirements in final paragraphs (b)(2)(vii)(A) and (b)(2)(vii)(B) are also equivalent to the tests required by ASTM F887–12^{e1} (Section 15.3.1 and Note 2). It is not clear why ASTM included the requirement that positioning straps pass a withstand test in a note rather than in the rule itself. OSHA is including the requirement that positioning straps be capable of passing a withstand test in the text of final § 1926.954(b)(2)(vii)(A) to make it clear that this provision is mandatory. The Agency believes that straps currently being manufactured and used usually meet the final provisions. There is no evidence in the rulemaking record that current positioning straps do not meet these requirements. Therefore, OSHA is including paragraphs (b)(2)(vii)(A) and (b)(2)(vii)(B) in the final rule as proposed.

Paragraphs (b)(2)(vii)(C) and (b)(2)(vii)(D), which are being adopted without substantive change from the proposal, contain new requirements for positioning straps to be capable of passing tension tests and buckle-tear tests. These tests are based on ASTM F887–04, sections 15.3.2 and 15.3.3, and will ensure that individual parts of positioning straps have adequate strength and will not fail during a fall.[125]

Paragraph (b)(2)(vii)(E) requires positioning straps to be capable of passing a flammability test (described in Table V–1). This requirement, and the test in Table V–1, are based on ASTM F887–04, Section 15.3.4.[126] If an electric arc occurs while an employee is working, the work-positioning equipment must be capable of supporting the employee in case he or she loses consciousness. It is particularly important for the positioning strap to be resistant to igniting, because, once ignited, it would quickly lose its strength and fail.

Mr. Pat McAlister with Henry County REMC questioned the "value in the proposed arc testing requirement" because his company was "not aware of any situation where exposure to thermal energy has contributed to failure of" positioning straps (Ex. 0210).

OSHA responds that, although paragraph (b)(2)(vii)(E) will help ensure that positioning straps do not fail if an electric arc occurs, the standard just requires positioning straps to be capable of passing a flammability test; the standard does not require electric-arc testing. As noted later in the discussion of § 1926.960(g) of the final rule, electric power generation, transmission, and distribution work exposes employees to hazards from electric arcs. Paragraph (b)(2)(vii)(E) of § 1926.954 protects against some of those hazards, including ignition of the positioning strap, which could lead to failure of the strap and burns to the employee. ASTM F887 has required positioning straps to be capable of passing a flammability test since 1988, so the Agency is not surprised that Mr. McAlister is not aware of failures of positioning straps in electric-arc exposures. Having ASTM adopt a requirement for positioning straps to pass a flammability test is evidence that the consensus of industry opinion is that such testing is necessary. Therefore, OSHA is including paragraph (b)(2)(vii)(E) in the final rule as proposed. (OSHA, however, has made nonsubstantive, clarifying changes to final Table V–1.)

[124] The preamble to the proposal asked specifically about the withstand test requirement proposed in paragraph (b)(2)(vii)(A); however, most commenters responded to the question of whether there is a need to perform electrical tests on positioning straps (the withstand test and the leakage test proposed in paragraph (b)(2)(vii)(B)).

[125] These requirements are also contained in the latest edition, ASTM F887–12^{e1}, in Section 15.3.2 and 15.3.3.

[126] This requirement is also contained in the latest edition, ASTM F887–12^{e1}, in Section 15.3.4.

Paragraph (b)(2)(viii), which is being adopted without substantive change from the proposal, requires the cushion part of a body belt to be at least 76 millimeters (3 inches) wide, with no exposed rivets on the inside. This requirement is equivalent to existing § 1926.959(b)(2)(i) and (ii).

Existing § 1926.959(b)(2)(iii), which requires the cushion part of the body belt to be at least 0.15625 inches thick if made of leather, was omitted from the final rule. The strength of the body belt assembly, which this existing provision addresses, is now adequately addressed by the performance-based strength criteria specified in final § 1926.954(b)(2)(xii) (discussed later in this section of the preamble). Additionally, as noted previously, load-bearing portions of the body belt may no longer be constructed of leather alone under paragraph (b)(2)(v) of the final rule.

Paragraph (b)(2)(ix), which is being adopted without substantive change from the proposal, requires that tool loops on a body belt be situated so that the 100 millimeters (4 inches) at the center of the back of the body belt (measured from D ring to D ring) are free of tool loops and other attachments. OSHA based this requirement on ASTM F887–04, Section 14.4.3,[126] which is similar to existing § 1926.959(b)(3). This requirement will prevent spine injuries to employees who fall onto their backs while wearing a body belt, which could happen to an employee walking on the ground before or after climbing a pole.

Existing § 1926.959(b)(2)(iv) requires body belts to contain pocket tabs for attaching tool pockets. ASTM F887–04 also contained a requirement that body belts have pocket tabs. In the proposal, OSHA stated that it did not consider provisions regarding pocket tabs to be necessary for the protection of employees; the Agency believed that these requirements ensured that body belts were suitable as tool belts, but did not contribute significantly to the safety of employees (70 FR 34851).

ASTM Committee F18 on Electrical Protective Equipment for Workers clarified the purpose of the requirements for pocket tabs in the consensus standard as follows:

> [Pocket tabs are] addressed in ASTM F887–04, Section 14.4.1[127] as follows: "The belt shall have pocket tabs extending at least 1½" (3.8 cm) down, and with the point of attachment at least 3 in. (7.6 cm) back of the inside of the circle dee rings on each side for the attachment of pliers or tool pockets. On shifting dee belts, the measurement for pocket tabs shall be taken when the dee ring section is centered."
>
> * * * * *
>
> The primary reason for the specific placement of these pocket tabs is to assist in eliminating the interference of tools being carried on the belt with the proper engagement of a positioning strap snaphook into the body belt dee ring.
>
> Therefore, this detail is important for the safety of employees using these body belts. [Ex. 0148]

The committee recommended that OSHA either adopt the ASTM language or incorporate it by reference.

OSHA does not believe that pocket tabs are a hazard. The tabs are flush with the body belt and extend down from it. They do not interfere with the attachment of snaphooks to the D rings. OSHA agrees that tool pockets fastened to the tabs, or the tools in those pockets, could interfere under certain conditions. For example, a large tool or pocket could interfere with the attachment of snaphooks and D rings even with the tabs positioned as required by the consensus standard. The Agency believes that this hazard is better addressed by the general requirement in final paragraph (b)(3)(i) (discussed later in this section of the preamble) that work-positioning equipment be inspected to ensure that it is in safe working condition before use. In addition, the ASTM committee did not explain why tabs are necessary in the first place. Therefore, OSHA is not adopting the committee's recommendation to add the ASTM requirement on pocket tabs in the final rule.

Existing § 1926.959(b)(3) permits a maximum of four tool loops on body belts. As explained in the preamble to the proposal, OSHA does not believe that this provision is necessary for the protection of employees (70 FR 34851). Like existing § 1926.959(b)(2)(iv), this requirement ensures only that body belts are suitable as tool belts. OSHA received no comments on the proposed removal of this requirement, and the final rule removes this requirement from subpart V.[128]

Paragraph (b)(2)(x), which is being adopted without change from the proposal, requires copper, steel, or equivalent liners to be used around the bars of D rings. This provision, which duplicates existing § 1926.959(b)(4), will prevent wear between the D ring and the body belt fabric. Such wear could contribute to failure of the body belt during use.

In paragraph (b)(2)(xi), OSHA proposed that snaphooks used as part of work-positioning equipment be of the locking type. A snaphook has a keeper designed to prevent the D ring to which it is attached from coming out of the opening of the snaphook. (See Figure 1.) However, if the design of the snaphook is not compatible with the design of the D ring, the D ring can roll around, press open the keeper, and free itself from the snaphook. (See Figure 2.)

[127] Section 14.3.1 in ASTM F887–12[e1] contains an identical requirement.

[128] Existing § 1926.959(b)(3) also requires the 100-millimeter (4-inch) section of the body belt in the middle of the back to be free of tool loops and other attachments. This portion of the existing paragraph is retained as § 1926.954(b)(2)(ix) in the final rule, as described previously.

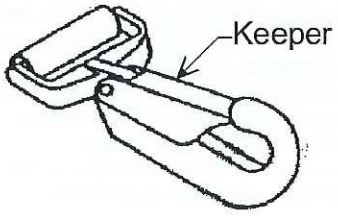

Figure 1—Snaphook

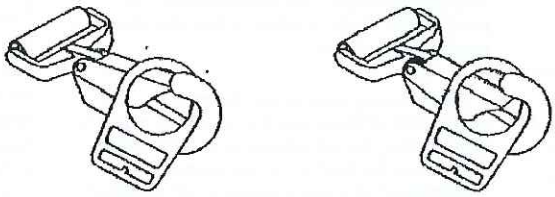

Figure 2—Snaphook Rollout

For many years, ASTM F887 had a requirement that snaphooks be compatible with the D rings with which they were used. Even with this requirement, however, accidents resulting from snaphook roll-outs still occurred. As OSHA explained in the preamble to the proposal, several factors account for this condition (70 FR 34852). First, while one manufacturer can (and most do) thoroughly test its snaphooks and its D rings to ensure "compatibility," no manufacturer can test its hardware in every conceivable combination with other manufacturers' hardware, especially since some models of snaphooks and D rings are no longer manufactured. While an employer might be able to test all of the different hardware combinations with its existing equipment, the employer normally does not have the expertise necessary to conduct such tests in a comprehensive manner. Second, snaphook keepers can be depressed by objects other than the D rings to which they are attached. For example, a loose guy (a support line) could fall onto the keeper while an employee is repositioning himself or herself. This situation could allow the D ring to escape from the snaphook, and the employee would fall as soon as he or she leaned back into the work-positioning equipment. The locking-type snaphooks OSHA proposed to require will not open unless employees release the locking mechanisms.

A few commenters objected to the requirement for locking snaphooks, maintaining that existing pole straps with nonlocking snaphooks have been used safely and effectively for many years. (See, for example, Exs. 0210, 0225.) Mr. Jonathan Glazier with the National Rural Electric Cooperative Association (NRECA) questioned the safety benefits of locking snaphooks, commenting:

> Is the cost of replacing the thousands of non-locking snaphooks in use today outweighed by the benefit? Certainly workers are familiar with the rudimentary technology presented by non-locking snaphooks, so the danger they present is low. [Ex. 0233]

A majority of the rulemaking participants who commented on this issue agreed that the proposed requirement for locking snaphooks was justified. (See, for example, Exs. 0167, 0169, 0213; Tr. 579.) For instance, Quanta Services commented that "the current requirement [to use] snaphooks compatible with the particular D rings with which they are used is not sufficient because accidents from snaphook rollover still occur" and agreed with OSHA that the proposal to require locking snaphooks "will provide greater protection" (Ex. 0169).

Snaphook rollout is a recognized hazard, as indicated by updated requirements in the consensus standard. The ASTM committee believed that the former requirement for compatibility between snaphooks and D rings was inadequate to protect employees; thus, the committee included a requirement for locking snaphooks in ASTM F887–04 (Ex. 0055). Evidence in the record indicates that the committee was correct; one exhibit showed that two workers were killed when the snaphooks they were using apparently rolled out (Ex. 0003).[129] OSHA considered the record on this issue and concluded that the proposed requirement for locking snaphooks is justified; therefore, the Agency is including the proposed provision in the final rule.

Mr. Lee Marchessault with Workplace Safety Solutions recommended that the term "double locking type" be used rather than "locking type" (Ex. 0196; Tr. 579). His comment addressed the reference to locking snaphooks in proposed paragraph (b)(3)(vi) (discussed later in this section of the preamble), but, because paragraph (b)(2)(xi) contains the requirement that snaphooks on positioning straps be of the locking type, his comment applies equally here.

The devices specified in the standard are "locking snaphooks." They are also known as "double-locking snaphooks." However, this latter term is a misnomer. There is only a single locking mechanism. The keeper, which "keeps" the snaphook on the D ring, is not self-locking. Consequently, these devices are correctly known as "locking

[129] Descriptions of these two accidents can be viewed at: *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=922336&id=14340061.*

snaphooks," and OSHA is using this term in the final rule.

In issuing the proposal, OSHA recognized that there might be thousands of existing nonlocking snaphooks currently in use and requested comment on whether it should phase in the requirement for locking snaphooks for older equipment or allow employers to continue using existing equipment that otherwise complies with the standard until it wears out and must be replaced.

Several commenters recommended grandfathering existing equipment and requiring that only newly purchased positioning straps be equipped with locking snaphooks. (See, for example, Exs. 0162, 0175, 0210, 0224, 0225, 0227, 0233.) For instance, the Virginia, Maryland & Delaware Association of Electric Cooperatives commented:

> [G]randfathering existing equipment for those companies that have not started utilizing locking snap-hooks is prudent. For companies currently using older equipment, the requirement should be that as the older equipment is phased out or worn out, new equipment must be the locking snap-hook type. [Ex. 0175]

In addition, Mr. Glazier with NRECA was concerned that requiring an immediate switch to locking snaphooks could lead to a shortage of compliant equipment (Ex. 0233).

Other commenters argued that there should be little or no phase-in period because nonlocking snaphooks have not been available for over 10 years and because employees would be left at risk. (See, for example, Exs. 0148, 0199, 0212.) TVA commented that it had "prohibited nonlocking snaphooks for a number of years" before OSHA's proposal (Ex. 0213). The Southern Company and ASTM Committee F18 recommended a phase-in period of no more than 12 months (Exs. 0148, 0212). Buckingham Manufacturing Company recommended a phase-in period of no more than 3 months (Ex. 0199).

According to the ASTM committee, manufacturers stopped producing nonlocking snaphooks before 1998 (Ex. 0148). In addition, evidence in the record indicates that the average useful life of a body belt or body harness is 5 years (Ex. 0080). The Agency believes that the useful life of positioning straps (to which snaphooks are affixed) also is approximately 5 years because they are made from the same materials and are subject to the same conditions of use. Thus, any nonlocking snaphooks still remaining in use are substantially beyond their expected useful life and are probably in need of replacement. In addition, there is evidence in the record that the vast majority of positioning straps in use already have locking snaphooks. Mr. James Tomaseski of IBEW testified that, based on a survey of the union's members, 80 percent of electric utilities and contractors performing work covered by the final rule require the use of locking snaphooks (Tr. 976). He also testified that locking snaphooks are used even by companies that do not require them and that there will not be a problem with availability (Tr. 975–976). Therefore, OSHA concludes that a phase-in period of 90 days should be adequate to comply with the requirement. Compliance with paragraph (b)(2)(xi) is required on the effective date of the final rule: July 10, 2014.

OSHA proposed three requirements for locking snaphooks to ensure that keepers do not open without employees intentionally releasing them. First, for the keeper to open, a locking mechanism would have to be released, or a destructive force would have to be impressed on the keeper (paragraph (b)(2)(xi)(A)). Second, a force in the range of 6.7 N (1.5 lbf) to 17.8 N (4 lbf) would be required to release the locking mechanism (paragraph (b)(2)(xi)(B)). Third, with a force on the keeper and the locking mechanism released, the keeper must be designed not to open with a force of 11.2 N (2.5 lbf) or less, and the keeper must begin to open before the force exceeds 17.8 N (4 lbf) (paragraph (b)(2)(xi)(C)).[130] These requirements are based on ASTM F887–04, section 15.4.1.[131] Proposed paragraph (b)(2)(xi)(C), relating to the spring tension on the keeper, was equivalent to existing § 1926.959(b)(6).

Mr. Daniel Shipp with ISEA objected to these proposed requirements and maintained that the provisions on work-positioning equipment should be consistent with § 1910.66 (Powered platforms for building maintenance), Appendix C, and § 1926.502 (Fall protection systems criteria and practices), commenting:

> Neither of these [existing] standards set forth detailed specifications for the forces required to actuate the locking and gate mechanisms of snaphooks. The determining factors that relate most closely to incidents of accidental disengagement of a snaphook from its connector are (a) the compatibility in size and shape of the connecting element, and (b) the tensile strength of the gate in the closed and locked position, which are fully discussed in 1910.66 and 1926.502. It is difficult to envision one range of force requirements that would apply equally to all locking snaphooks because of the wide variety of existing and possible snaphook designs.
>
> OSHA should limit its regulation of self-closing and self-locking snaphooks to use in work positioning applications that follow existing fall protection regulations. The addition of further restrictive requirements will have the effect of possibly eliminating otherwise safe and efficient equipment from the marketplace without any demonstrable improvement in worker safety. [Ex. 0211]

It is not clear from Mr. Shipp's comment whether he opposes the requirement that snaphooks be of the locking type. If he does, there is ample evidence in the record, as discussed previously, to support the adoption of a requirement for locking snaphooks. Therefore, the Agency will focus on his comments relating to the forces used to unlock and open keepers. The proposed paragraphs ensure the adequacy of the locking mechanism by requiring a destructive force to open the keeper if it is not first unlocked and by specifying the minimum force required to open the locking mechanism. The proposed paragraphs also ensure that the keeper does not open unintentionally if the locking mechanism is opened accidentally (for example, by a loose conductor striking it), or if it breaks.

In addition to specifying minimum forces, the proposed paragraphs specified the maximum forces necessary to open the locking mechanism and the keeper when the locking mechanism is open. Because this equipment is frequently used with rubber insulating gloves and leather protectors, employees have limited dexterity when they are opening and closing keepers (Ex. 0173). Snaphook keepers that are too difficult to unlock or open by employees wearing rubber insulating gloves could interfere with connecting a snaphook to a D ring and lead to falls. In addition, employees develop a rhythm, buckling and unbuckling the positioning straps into the D rings of their body belts (see, for example, 269–Ex. 3–11). Snaphook keepers that are too difficult to unlock or open will interfere with this rhythm, potentially leading to falls. These conditions are not present for employees working from power platforms covered by § 1910.66 or in general construction work covered by § 1926.502.

As noted previously, existing subpart V already requires the opening force on the keeper to be within the range specified in the proposal. Also, the inclusion of similar provisions in ASTM F887 is evidence that the ASTM committee concluded that there is a need for the requirements proposed in paragraph (b)(2)(xi). For these reasons,

[130] In proposed paragraphs (b)(2)(xi)(B) and (b)(2)(xi)(C), the metric units were not equal to the English units. The metric units were corrected in the final rule.

[131] These requirement are also contained in the latest edition, ASTM F887–12^{e1}, in Section 15.4.2.1.

OSHA is including paragraphs (b)(2)(xi)(A), (b)(2)(xi)(B), and (b)(2)(xi)(C) in the final rule as proposed. (As previously noted, OSHA has corrected the metric units in these provisions in the final rule.)

Mr. Frank Owen Brockman of Farmers Rural Electric Cooperative Corporation recommended that OSHA prohibit the use of any snaphook that requires employees to remove gloves before opening the snaphook (Ex. 0173). As noted earlier, the objective performance requirements in paragraph (b)(2)(xi) will ensure that snaphooks meeting the standard are usable by employees wearing rubber insulating gloves and leather protectors. The Agency does not believe that adding a requirement that snaphooks be capable of being opened by an employee wearing gloves will improve the safety of these devices. OSHA believes, however, that employers will consider this facet of snaphook design when selecting positioning straps, if only to minimize employee complaints.

Existing § 1926.959(b)(7) requires body belts, safety straps, and lanyards to be capable of passing a drop test in which a test load is dropped from a specific height and the equipment arrests the fall. The test consists of dropping a 113.4-kg (250-lbm) bag of sand a distance of either 1.2 meters (4 feet) or 1.8 meters (6 feet), for safety straps and lanyards, respectively.[132]

OSHA explained in the preamble to the proposal that ASTM adopted a different test in ASTM F887–04 (70 FR 34853). Under the existing OSHA test, the bag of sand can be fitted with the body belt in different ways, resulting in tests that are not necessarily consistent among different testing laboratories. To overcome this problem, ASTM 887–04 adopted a drop test that uses a rigid steel mass of a specified design. To compensate for differences between a rigid mass and the more deformable human body, the ASTM standard uses a lower test mass, 100 kg (220 lbm), and a shorter drop height, 1 meter (39.4 inches). OSHA proposed to replace the drop test in existing § 1926.959(b)(7) with a test modeled on the test specified in the 2004 ASTM standard.[133]

Proposed paragraph (b)(2)(xii)(A) would have required the test mass to be rigidly constructed of steel or equivalent material having a mass of 100 kg (220.5 lbm). OSHA explained in the proposal that this mass was comparable to the 113.4-kg (250-lbm) bag of sand that must be used under the existing OSHA standard (70 FR 34853). Even though the proposed test mass was lighter than a heavy power line worker, OSHA explained that the proposed test method would place significantly more stress on the equipment than an employee of the same mass because the test drop was greater than the maximum permitted free-fall distance and because the test mass was rigid (*id.*).

Proposed paragraphs (b)(2)(xii)(B) and (b)(2)(xii)(C) specified the means used to attach body belts and positioning straps during testing. These provisions would ensure that the work-positioning equipment being tested was properly attached to the test apparatus.

Proposed paragraph (b)(2)(xii)(D) provided for the test mass to be dropped an unobstructed distance of 1 meter (39.4 inches). OSHA explained in the preamble that, for positioning straps, this distance was equivalent (given the rigid test mass) to the existing standard's test distance of 1.2 meters (4 feet) (70 FR 34853).

Proposed paragraphs (b)(2)(xii)(E) and (b)(2)(xii)(F) specified the following acceptance criteria for tested equipment: (1) Body belts would have had to arrest the fall successfully and be capable of supporting the test mass after the test, and (2) positioning straps would have had to successfully arrest the fall without breaking or allowing an arresting force exceeding 17.8 kilonewtons (4,000 pounds-force). Additionally, the proposal provided that snaphooks on positioning straps not distort sufficiently to allow release of the keeper.

OSHA requested comment on whether the proposed test was reasonable and appropriate and, more specifically, whether the requirement for a rigid test mass of 100 kg (220.5 lbm) dropped a distance of 1 meter (39.4 inches) was sufficiently protective.

Most rulemaking participants who commented on this issue supported the proposed requirements. (See, for example, Exs. 0126, 0199, 0230.) For instance, IBEW commented:

> This change has been accepted in the ASTM standard. The ASTM Technical Subcommittee realized more consistent results were necessary, and therefore, through experimentation with different test methods, developed the test method using a specific design of a rigid steel mass. OSHA should recognize this test method as the best industry practice. [Ex. 0230]

Two commenters noted that the test mass specified in the proposed rule was adequate for workers weighing up to 140 kg (310 lbm) (Exs. 0199, 0211). Mr. James Rullo of Buckingham Manufacturing explained:

> The standard conversion factor used in the industry for the sand bag to steel mass is 1.4 which when applied to the 220.5 lbm equates to 310 lbm. That would seem to cover the general range of line workers. In addition, the straight drop with the wire cable imposes forces on the equipment which we believe to be more severe than most falls that might be experienced by line workers. [Ex. 0199]

Mr. Daniel Shipp with ISEA supported the proposal's requirement for testing with a 100-kg rigid test mass, but recommended a modification for workers weighing more than 140 kg:

> ISEA supports the change to a test mass of rigid steel construction, weighing 100 kg (220 lb). Our members' experience in testing fall protection products leads us to conclude that the rigid mass will produce more repeatable results than testing with a sand-filled bag. However, we believe the 100 kg test mass should only be sufficient to qualify products for use by employees with a maximum body weight up to 140 kg (310 lb). For employees with weights greater [than] 140 kg (310 lb), including body weight, clothing, tools and other user-borne objects, the test should be modified to increase the test mass proportionately greater than 100 kg (220 lb). For example, for a worker with an all-up weight of 160 kg (354 lb), the test mass should be increased to 114 kg (251 lb). [Ex. 0211]

The ASTM committee and the fall-protection equipment-manufacturing industry recognize the proposed tests as being reasonable and adequate. As some of the commenters noted, the proposed test mass will impose sufficient stress on work-positioning equipment for a worker weighing 140 kg (310 lbm), including tools and equipment. However, OSHA concludes that the proposed test is insufficiently protective for workers weighing more than 140 kg when fully equipped. Therefore, the Agency is adopting paragraph (b)(2)(xii)(A) as proposed, except that the final rule requires work-positioning equipment used by employees with an equipped weight of more than 140 kg to be capable of passing the same test, but with a test mass of proportionally greater mass (that is, the test mass must equal the mass of the equipped worker divided by 1.4). With this change, the final rule will ensure that work-positioning equipment will adequately protect even the heaviest workers. OSHA believes that, if any equipped worker has a mass greater than 140 kg, the employer will order work-positioning equipment that is adequate for the increased mass and that

[132] As noted earlier, existing § 1926.959 covers body belts, safety straps, and lanyards as both fall arrest and work-positioning equipment. Paragraph (b)(2) of final § 1926.954 covers only work-positioning equipment. Lanyards, which are used in fall arrest and are not covered in final § 1926.954(b)(2), have to be capable of withstanding higher forces as required by § 1926.502(d)(9).

[133] ASTM F887–12^{e1} specifies equivalent test procedures and criteria for this equipment.

manufacturers will supply work-positioning equipment that has been tested with a mass that conforms to the standard.

In the final rule, OSHA is adopting the remaining provisions in § 1926.954(b)(2)(xii), namely paragraphs (b)(2)(xii)(B) through (b)(2)(xii)(F), without substantive change from the proposal.

OSHA proposed three notes to paragraph (b)(2). The first note indicated that paragraph (b)(2) applies to all work-positioning equipment used in work covered by subpart V. The Agency is not including this note in the final rule as it is unnecessary.

The Ohio Rural Electric Cooperatives suggested that, instead of the specific provisions proposed in paragraph (b)(2), the standard require only that belts be certified to ASTM F887–04 (Ex. 0186). A note to final paragraph (b)(2) (Note 2 in the proposal), which appears after final paragraph (b)(2)(xii)(F), provides that, when used by employees weighing no more than 140 kg (310 lbm) fully equipped, body belts and positioning straps that conform to ASTM F887–12 ^{e1}, the most recent edition of that standard, are deemed to be in compliance with paragraph (b)(2). This note clearly informs employers that body belts and positioning straps meeting that consensus standard also meet the testing requirements in OSHA's final rule. To avoid confusion, the Agency removed the phrase "the manufacturing and construction requirements of," which modified "paragraph (b)(2) of this section" and which appeared in the proposal, from the language of this note in the final rule. The purpose of this phrase was to describe the contents of paragraph (b)(2) rather than restrict the application of the note. The Agency restricted the application of the note in the final rule to body belts and safety straps used by employees weighing no more than 140 kg (310 lbm), as the ASTM standard does not address this aspect of the final rule.[134]

Note 2 in the proposal provided that work-positioning equipment meeting the consensus standard also needed to meet proposed paragraphs (b)(2)(iv), which specified tensile testing for snaphooks, and (b)(2)(xi), which required snaphooks to be of the locking type. ASTM Committee F18 stated that ASTM F887–04 contained nearly identical requirements and suggested that the note omit references to those two proposed paragraphs (Ex. 0148). OSHA agrees that ASTM F887–04 adequately covered all the requirements in final paragraph (b)(2), and OSHA removed the two referenced paragraphs (paragraphs (b)(2)(iv) and (b)(2)(xi)) from the note in the final rule. In addition, the Agency reviewed the latest edition of the ASTM standard, ASTM F887–12 ^{e1}, and found that it also adequately addresses all of the design requirements in the final rule. Consequently, the note in the final rule states that, when used by employees weighing no more than 140 kg (310 lbm) fully equipped, body belts and positioning straps meeting this later edition of the consensus standard will be deemed as complying with paragraph (b)(2).

OSHA also proposed a third note to paragraph (b)(2) indicating that body belts and positioning straps meeting § 1926.502(e) on positioning device systems would be deemed to be in compliance with the manufacturing and construction requirements of paragraph (b)(2) of proposed § 1926.954, provided that the equipment also conformed to proposed paragraph (b)(2)(vii), which contained provisions addressing electrical and flame-resistance tests for positioning straps, as well as requirements for positioning straps to be capable of withstanding a tension test and a buckle-tear test. The preamble to the proposal explained that body belts and positioning straps that are parts of positioning device systems addressed by § 1926.502(e) serve the same function as work-positioning equipment used for work covered by subpart V (70 FR 34853). OSHA originally believed that body belts and positioning straps that met the design criteria specified by § 1926.502(e), as well as the provisions in proposed § 1926.954(b)(2)(vii), would generally be sufficiently strong for power line work.

OSHA reexamined the need for, and appropriateness of, proposed Note 3 to § 1926.954(b)(2) in light of the rulemaking record for subpart V. As indicated by Mr. Daniel Shipp with ISEA, § 1926.502(e) does not contain requirements comparable to those in final § 1926.954(b)(2)(xi)(B) and (b)(2)(xi)(C) for the minimum and maximum opening and closing forces for snaphook keepers and locking mechanisms. As explained in the discussion of final § 1926.954(b)(2)(xi) earlier in this section of the preamble, OSHA believes that snaphooks must meet these performance requirements to be adequately protective in the conditions encountered by employees performing work covered by Subpart V. In addition, § 1926.502(e) does not contain requirements comparable to several other provisions of final § 1926.954(b)(2), including those prohibiting leather in load-bearing components of body-belt and positioning-strap assemblies (paragraph (b)(2)(v)), prohibiting tool loops in the center 100 millimeters (4 inches) of the back of a body belt (paragraph (b)(2)(ix)), and requiring a maximum arresting force during the drop test (paragraph (b)(2)(xii)(F)). OSHA believes that these also are important requirements necessary for the safety of employees performing work covered by Subpart V. Consequently, OSHA is not including Note 3 to proposed § 1926.954(b)(2) in the final rule.

Some commenters were concerned that the proposal required the tests in paragraph (b)(2) to be conducted by the employer. (See, for example, Exs. 0169, 0175, 0186.) OSHA notes that the final rule states that work-positioning equipment must be "capable" of passing these tests. The tests in the final rule could be performed by the manufacturer on samples that are representative of the finished product. However, it will be the employer's responsibility to ensure that it selects, and has its employees use, a type of equipment that has been subject to adequate testing by the manufacturer. The final rule does not require employers to conduct the tests specified by paragraph (b)(2) when the manufacturer conducts such testing. Employers will be able to determine, in most instances, whether work-positioning equipment meets the OSHA standard simply by ensuring that the manufacturer has tested the equipment in accordance with the OSHA standard or ASTM F887–12 ^{e1}. The tests required by paragraph (b)(2) are potentially destructive and should never be performed on work-positioning equipment that will be used by employees (Exs. 0055, 0072).

Paragraph (b)(3) addresses the care and use of fall protection equipment. As OSHA explained in the preamble to the proposal, fall protection equipment provides maximum protection only when it is properly used and maintained (70 FR 34853). Existing § 1926.951(b)(3) requires this equipment to be inspected each day before use. OSHA believed that this requirement had to be supplemented by additional requirements to protect employees fully from fall hazards posed by electric power transmission and distribution work and, therefore, proposed to add requirements to subpart V, borrowed from existing § 1910.269(g)(2) and § 1926.502(d) and (e), regulating the care and use of fall protection equipment.

[134] Body belts and safety straps that meet ASTM F887–12 ^{e1}, but with the test weight adjusted as required by § 1926.954(b)(2)(xii)(A), will be deemed to be in compliance with final § 1926.954(b)(2).

Paragraph (b)(3)(i) requires the employer to ensure that work-positioning equipment is inspected before use each day to determine if it is in safe working condition. (Paragraph (d)(21) of § 1926.502 already contains a similar requirement for fall arrest equipment that applies, and will continue to apply, to work covered by Subpart V.) Paragraph (b)(3)(i) also prohibits the use of work-positioning equipment that is not in safe working condition. The proposal was worded to prohibit the use of "defective equipment." OSHA replaced this term in the final rule with "equipment that is not in safe working condition" and added "work-positioning" before "equipment" to clarify that this provision applies to any condition that would make work-positioning equipment unsafe. This language also makes it consistent with the requirement in this paragraph to inspect the equipment to determine if it is in "safe working condition." This paragraph ensures that protective equipment will be capable of protecting employees when needed. This requirement is similar to existing § 1926.951(b)(3), except that the prohibition on the use of unsafe equipment is now stated explicitly. A thorough inspection of fall protection equipment can detect defects such as cracked snaphooks and D rings, frayed lanyards, loose snaphook keepers, and bent buckles. A note to this paragraph states that a guide to the inspection of this equipment is included in Appendix F.

Paragraph (b)(3)(ii) requires personal fall arrest systems to be used in accordance with § 1926.502(d). Paragraph (d)(21) of § 1926.502 provides: "Personal fall arrest systems shall be inspected prior to each use for wear, damage and other deterioration, and defective components shall be removed from service." Removing "defective" equipment from service in accordance with § 1926.502(d)(21) will ensure that employees are not using fall arrest equipment that is not in safe working condition.[135]

OSHA explained in the proposal that personal fall arrest equipment is sometimes used as work-positioning equipment such that the employee can lean into the body harness and perform work (70 FR 34854). In this scenario, the normal attachment point would be at waist level. Paragraph (d)(17) of § 1926.502 requires the attachment point for body harnesses to be located in the center of the employee's back near shoulder level or above his or her head. As the Agency explained in the preamble to the proposal, such an attachment could prevent the employee from performing his or her job while the employee is using work-positioning equipment (*id.*), so OSHA proposed to exempt fall arrest equipment used as work-positioning equipment from this requirement if the equipment was rigged so that the maximum free-fall distance was no greater than 0.6 meters (2 feet).

Mr. Daniel Shipp with ISEA agreed with the proposal, commenting:

> ISEA agrees with the proposed change to allow frontal-attachment for personal fall arrest on equipment that is used for work positioning, with a maximum permissible free fall distance of 0.6 m (2 ft). [Ex. 0211]

OSHA reconsidered including this exception in the regulatory text of paragraph (b)(3)(ii) and concluded that it is unnecessary. Fall arrest equipment that is rigged for work positioning is considered to be work-positioning equipment for the purposes of final § 1926.954(b). When fall protection equipment is rigged for work positioning, the equipment must meet the requirements in paragraph (b) that apply to work-positioning equipment, and the provisions that apply to fall arrest systems, including the anchorage requirement in § 1926.502(d)(17), are not applicable. When fall protection equipment is rigged to arrest falls, the equipment is considered to be a fall arrest system, and the provisions for those systems apply. OSHA included a note to paragraph (b)(3)(ii) to clarify this point.

In paragraph (b)(3)(iii), OSHA proposed to require the use of a personal fall arrest system or work-positioning equipment by employees working at elevated locations more than 1.2 meters (4 feet) above the ground on poles, towers, and similar structures if other fall protection has not been provided. As OSHA clarified in the proposal, the term "similar structures" includes any structure that supports electric power transmission or distribution lines or equipment, such as lattice substation structures and H-frame wood transmission structures (70 FR 34854). A similar requirement is in existing § 1910.269(g)(2)(v). (In existing § 1926.951(b)(1), OSHA requires fall protection for "employees working at elevated locations," but does not specify a height at which such protection becomes necessary.) Note 1 to proposed paragraph (b)(3)(iii) indicated that these fall protection requirements did not apply to portions of buildings, electric equipment, or aerial lifts, and referred to the relevant portions of the construction standards that do apply in those instances (that is, subpart M for walking and working surfaces generally and § 1926.453 for aerial lifts).[136]

Many rulemaking participants commented on the proposed requirement to use fall protection starting at 1.2 meters (4 feet) above the ground. (See, for example, Exs. 0173, 0183, 0186, 0196, 0202, 0210, 0219, 0229, 0233, 0239; Tr. 575–576.) Two commenters recommended that Subpart V mirror the Subpart M "6-foot rule," in other words, that fall protection not be required until an employee is 1.8 meters (6 feet) or more above the ground (Exs. 0196, 0219; Tr. 575–576). Lee Marchessault with Workplace Safety Solutions commented:

> [The proposal] requires fall protection when working at heights greater than 4 feet, however the referrence [*sic*] to 1926 subpart M requires 6 feet and therefore the fall protection system is designed to engage at distances not more than 6 feet. This renders the system useless for a 5 foot fall in some cases. An example may be working on a trash platform of a hydro generation facility cleaning racks that are 4.5 feet off the lower walking surface. A fall restraint system works best, but workers are allowed to use a harness and 6 foot lanyard. [Ex. 0196]

Mr. Marchessault suggested in testimony at the 2006 public hearing that using different length lanyards for different jobs would not be feasible (Tr. 576). The Virginia Maryland & Delaware Association of Electric Cooperatives commented that it did not see a need for OSHA to set any height threshold for fall protection in the standard, explaining: "Line work is inherently different than other occupations with climbing a necessary skill required in the trade. Therefore, specification of a distance does not add additional safety to the employee" (Ex. 0175).

Other commenters supported the proposed 1.2-meter height or stated that it generally has not presented problems since it was adopted in existing § 1910.269. (See, for example, Exs. 0186, 0211, 0213, 0230.) IBEW commented that "[t]he 1910.269 requirement [for fall protection starting at] 1.2 meters (4 feet) has proven not [to] be problematic. The addition of 2 feet will not offer anything to the requirement" (Ex. 0230).

[135] Subpart M, Appendix C, section II, paragraph (g) provides examples of defects that require removing equipment from service. Such defects include cuts, tears, abrasions, mold, or undue stretching; alterations or additions which might affect the efficiency of the equipment; damage due to deterioration; contact with fire, acids, or other corrosives; distorted hooks or faulty hook springs; tongues unfitted to the shoulder of buckles; loose or damaged mountings; nonfunctioning parts; or wearing or internal deterioration in the ropes.

[136] As noted earlier, the corresponding note in the final rule does not pertain to fall protection for employees in aerial lifts or reference § 1926.453.

Most of the comments relating to the starting height for fall protection were from electric cooperatives or their representatives who recommended that OSHA not require fall protection until 3 meters (10 feet) above the ground for employees who are undergoing training. (See, for example, Exs. 0183, 0186, 0202, 0210, 0229, 0233, 0239.) For instance, Mr. Anthony Ahern of Ohio Rural Electric Cooperatives commented:

> [F]or training purposes it would be nice to have the option of going to 10 feet without fall protection . . . under close supervision. At a height of only 4 [feet] a climber really does not get a sense of height. Using fall arrest equipment at higher levels gives the new climber a false sense of security, can hinder mobility and make it more difficult to move around the pole. Being able to work new climbers up to 10 [feet] after demonstrating basic abilities at lower levels would give the new climber a better sense of working at heights and make it easier for trainers to determine which [climbers] need additional training or who simply can not handle working on a pole. [Ex. 0186]

NRECA maintained that "in the highly-supervised and specially-equipped environment of linemen training, the extra height adds very little, if any extra danger" (Ex. 0233).

As previously noted, the current requirement in § 1910.269(g)(2)(v) for fall protection starts at 1.2 meters (4 feet), and multiple commenters indicated that this provision is not causing problems. (See, for example, Exs. 0186, 0230.) Adjustable-length lanyards, retractable lanyards, and work-positioning equipment can serve to accommodate the varying heights at which an employee will be working (Ex. 0211). In addition, the relevant paragraph in the final rule (§ 1926.954(b)(3)(iii)(B)) does not apply to the example provided by Mr. Marchessault (the "trash platform of a hydro generation facility"), as such work locations are not "poles, towers, or similar structures." OSHA is not persuaded by the speculation that employees undergoing training experience a "false sense of security" or that employees using fall protection cannot be successfully trained in the use of free-climbing techniques. Employees undergoing training can use combination body belt-body harness systems that attach both to a retractable lanyard anchored to the top of a pole (for fall arrest) and to a positioning strap (for work positioning). This arrangement will ensure protection for the trainees until they master climbing techniques. Any sense of security the employee experiences using such equipment would not be "false," but rather would be based on real protection. There is evidence in the record that unprotected employees in training to climb wood poles have been injured (Ex. 0003 [137]). Several of these employees were climbing wood poles with wood chips at the base of the pole. The chips did not protect the employees, and they received serious injuries, for which all but one were hospitalized. OSHA has previously taken the position that wood chips do not provide adequate fall protection for employees, and the evidence in this rulemaking does not support a different conclusion. Under final § 1926.954(b)(3)(iii)(B), employers must provide employees with appropriate fall protection when they are in training to climb wood poles.[138]

The 1.2-meter threshold provides additional safety when compared to higher thresholds. The speed with which an employee will strike the ground increases with increasing height. An extra 0.6 meters (2 feet) in height increases fall velocity by over 20 percent, substantially increasing the potential severity of any injuries the employee receives. An extra 1.8 meters (6 feet) in height increases fall velocity by nearly 50 percent. After considering the comments in the record, OSHA concluded that the rationales offered by these commenters do not justify increasing the severity of the fall hazard by increasing the height threshold. Therefore, OSHA is adopting the proposed requirement for fall protection to start at 1.2 meters (4 feet) and, for the reasons described previously, is not adopting a less protective threshold for employees undergoing training.

Southern Company suggested that OSHA reference IEEE Std 1307–2004, *Standard for Fall Protection for Utility Work,* for work on transformers, circuit breakers, and other large equipment. That standard requires fall protection at heights of 3.05 meters (10 feet) and higher (Ex. 0212).

The duty to provide fall protection for work on electric equipment, such as transformers and capacitors, is not in Subpart V or § 1910.269, but rather in Part 1926, Subpart M, and Part 1910, Subpart D, for construction and general industry, respectively. The application of Subpart D rather than § 1910.269 to walking-working surfaces other than poles, towers, and similar structures was explained in the preamble to the 1994 § 1910.269 final rule (59 FR 4374) and in letters of interpretation.[139] The consensus standard's requirement for fall protection at heights over 3.05 meters conflicts with the more protective requirements in Subparts M and D. Also, for reasons noted earlier, the Agency concluded that an increase in the 1.2-meter (4-foot) and 1.8-meter (6-foot) threshold heights for initiating fall protection in Subparts D and M, respectively, is not warranted. It should be noted that IEEE Std 1307 is included in Appendix G, and employers may find that it contains useful information on how to provide fall protection for work covered by subpart V. However, OSHA concludes that a nonmandatory reference to the consensus standard for a situation to which § 1926.954(b)(3)(iii) does not apply, as recommended by Southern Company, would be inappropriate and misleading. Note 1 to proposed § 1926.954(b)(3)(iii) stated that "[t]he duty to provide fall protection associated with walking and working surfaces is contained in subpart M of this part." However, the relevant portion of existing § 1926.500(a) seems to indicate otherwise, stating that requirements relating to fall protection for employees engaged in the construction of electric transmission and distribution lines and equipment are provided in subpart V (see § 1926.500(a)(2)(vi)).

> As was clear from Note 1 to proposed § 1926.954(b)(3)(iii), OSHA was proposing that the duty to provide fall protection for general walking working surfaces, that is, everything other than aerial lifts and poles, towers, and similar structures, would be covered by subpart M. To clarify this point, in the final rule, OSHA is revising § 1926.500(a)(2)(vi) so that the subpart V exemption applies only to the duty to provide fall protection for aerial lifts and poles, towers, and similar structures.

Existing § 1910.269(g)(2)(v) permits travel-restricting equipment as an alternative to fall arrest or work-positioning systems. OSHA proposed to omit the use of travel-restricting equipment as a recognized fall protection system for electric power transmission and distribution work on poles, towers, and similar structures. In the preamble to the proposal, the Agency explained that travel-restricting equipment is only appropriate for work

[137] See, for example, the descriptions of five accidents at: *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=170157069&id=170181432&id=170175269&id=170176630&id=170204267.*

[138] As stated in Note 2 to paragraphs (b)(3)(iii)(B) and (b)(3)(iii)(C), employees who have not completed training in climbing and the use of fall protection are not considered "qualified employees" for the purposes of paragraph (b)(3)(iii)(C), which permits qualified employees to climb without fall protection in limited situations.

[139] See, for example, the October 18, 1995, letter to Mr. Lonnie Bell (*http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=21981*) and the December 18, 1997, letter to Mr. Dimitrios Mihou (*http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=22508*).

on open-sided platforms, where employees can walk around the working surface with the travel-restricting equipment keeping them from approaching too close to an unguarded edge (70 FR 34854). When it published the proposal, the Agency did not believe that this type of working surface could be found on poles, towers, or similar structures (*id.*). Therefore, OSHA did not include travel-restricting equipment as an acceptable fall protection system in proposed § 1926.954(b)(3)(iii) and proposed to remove the reference to travel-restricting equipment in existing § 1910.269(g)(2)(v), but invited comments on this omission.

Many commenters argued that there are surfaces used in work covered by Subpart V for which travel-restricting equipment is appropriate and recommended that OSHA restore travel-restricting equipment as an alternative form of fall protection. (See, for example, Exs. 0126, 0173, 0183, 0201, 0202, 0210, 0225, 0229, 0230, 0233, 0239.) However, few of these commenters provided specific, relevant examples. IBEW commented that travel-restricting equipment is sometimes used when an employee is transferring from a crossarm to a hook ladder or working or climbing above an energized circuit (Ex. 0230). In addition, Duke Energy asserted that the top of large transformers and rooftop installations were places where travel-restricting equipment could be used (Ex. 0201).

OSHA concludes that the examples provided by IBEW and Duke Energy are not relevant because the paragraph at issue does not apply to the tops of transformers or rooftops. Also, travel-restricting equipment, which is used to protect employees from fall hazards at unprotected edges, is not an appropriate form of fall protection for employees transferring from one location to another or for employees working or climbing above energized equipment.

Several commenters maintained that open-sided platforms are found on electric utility structures. (See, for example, Exs. 0126, 0183, 0202, 0229, 0233, 0239.) One of them, BGE, commented that it still has some open-sided platforms on switch structures (Ex. 0126).

OSHA previously concluded that equipment that can prevent an employee from falling, such as fall restraint equipment, is an acceptable form of fall protection. This conclusion is consistent with Agency policy as indicated in several letters of interpretation. (See, for example, letter dated November 2, 1995, to Mr. Mike Amen, *http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=21999*, and letter dated August 14, 2000, to Mr. Charles E. Hill, *http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=24110*.) The term "travel restricting equipment" appears only in existing § 1910.269; the equivalent terms "restraint system" and "tethering system" are used consistently throughout other OSHA standards, such as § 1926.760(a)(1), and official letters of interpretation (*id.*). The term "fall restraint system," as defined in § 1926.751 (in the steel erection standard), is a broad term that OSHA generally uses to refer to any equipment that prevents employees from falling. Thus, "fall restraint" includes travel-restricting equipment, tethering systems, and other systems that prevent falls from occurring. On the basis of comments received on travel-restricting equipment, OSHA believes that there are situations in which fall restraint systems can be used to protect employees performing work on poles, towers, and similar structures; therefore, the final rule includes these systems as an acceptable form of fall protection.

In reviewing the rulemaking record for § 1926.954, the Agency noted situations in which commenters appeared confused about the proper use of the various forms of fall protection. For example, the tree care industry believed that it was acceptable for employees working from aerial lifts to use work-positioning equipment (Exs. 0174, 0200, 0502, 0503), and IBEW condoned the use of travel-restricting equipment in what appear to be fall-arrest situations (Ex. 0230). OSHA adopted two changes in the final rule to clarify these terms. First, in §§ 1910.269(x) and 1926.968, OSHA is defining the three forms of fall protection listed in paragraph (b)(3)(iii) of the final rule.

The final rule defines "personal fall arrest system" as a system used to arrest an employee in a fall from a working level. This definition is borrowed from § 1926.500(b) in subpart M. The Agency is not, however, including the descriptive text following the definition in § 1926.500(b), which describes the various parts of personal fall arrest systems. Although this description is not a necessary part of the definition, OSHA notes that it describes personal fall arrest systems as consisting of an anchorage, connectors, and a body harness and indicates that such equipment may include a lanyard, deceleration device, lifeline, or suitable combinations of these.

The final rule defines "work-positioning equipment" as 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. This definition is based on the definition of "positioning device system" in § 1926.500(b) in subpart M. However, OSHA is replacing the example of vertical surface work in the subpart M definition with examples of vertical surfaces that are commonly found in electric power generation, transmission, and distribution work and that are covered by the final rule.

Finally, the final rule defines "fall restraint system" as a fall protection system that prevents the user from falling any distance. This definition is borrowed from § 1926.751, which specifies definitions for the steel erection standard in subpart R of part 1926. The Agency is not including the descriptive text following the definition, which describes the various parts of fall restraint systems. Although this description is not a necessary part of the definition, OSHA notes that it describes such systems as consisting of either a body belt or body harness, along with an anchorage, connectors and other necessary equipment. The final rule does not specify strength requirements for fall restraint systems; however, the system must be strong enough to restrain the worker from exposure to the fall hazard.[140]

Second, OSHA is adding the phrase "as appropriate" to the requirement in paragraph (b)(3)(iii)(B) to provide a personal fall arrest system, work-positioning equipment, or fall restraint system on poles, towers, or similar structures. This addition will make it clear that the system the employer chooses to implement must be appropriate for the situation, as indicated by the respective definitions. For example, because work-positioning equipment, by definition, is to be used on a vertical working surface, it would be inappropriate to use this equipment on horizontal working surfaces, such as a crossarm or horizontal tower arm.

[140] OSHA recommended more specific strength criteria in a letter of interpretation dated November 2, 1995, to Mr. Mike Amen (*http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=21999*). This letter stated: "OSHA has no specific standards for restraint systems, however, we suggest that as a minimum, fall restraint systems should have the capacity to withstand at least twice the maximum expected force that is needed to restrain the person from exposure to the fall hazard. In determining this force, consideration should be given to site-specific factors such as the force generated by a person walking, leaning, or sliding down the working surface."

With these modifications, the relevant provision in the final rule, which is in paragraph (b)(3)(iii)(B), states that, except as provided in paragraph (b)(3)(iii)(C), each employee in elevated locations more than 1.2 meters (4 feet) above the ground on poles, towers, or similar structures must use a personal fall arrest system, work-positioning equipment, or fall restraint system, as appropriate, if the employer has not provided other fall protection meeting Subpart M.

In the final rule, OSHA also added the phrase "meeting subpart M of this part" to clarify that the requirements of Subpart M apply to other forms of fall protection. The Agency is making a corresponding clarification in final § 1910.269(g)(2)(iv)(C)(2) that "other fall protection" must meet the general industry fall protection requirements in subpart D.

The Southern Company recommended that OSHA not specify the type of fall protection equipment to be used for open-sided platforms (Ex. 0212).

The language OSHA is adopting in paragraph (b)(3)(iii)(B) of the final rule provides the employer some latitude in deciding which form of fall protection is appropriate for employees working at elevated locations on poles, towers, and similar structures. However, the rule requires that the selected fall protection equipment be appropriate for the fall hazard. Using equipment for an application for which it is not designed exposes employees to hazards that were not considered in the design of the equipment. For example, an employee using work-positioning equipment in a fall-arrest situation could fall out of the equipment or be injured by fall-arrest forces. Thus, the Agency concludes that employers must select fall protection equipment that is appropriate for the hazard to which the employee is exposed. Consequently, an employee exposed to a fall hazard on an open-sided platform more than 1.2 meters (4 feet) above the ground must use either a fall arrest system or a fall restraint system, with the fall restraint system eliminating exposure to the fall hazard altogether.

Proposed paragraph (b)(3)(iii) included an exemption from fall protection requirements for qualified employees climbing or changing locations on poles, towers, or similar structures unless conditions, such as ice or high winds, could cause the employee to lose his or her grip or footing. Two rulemaking participants objected to the proposed provision allowing qualified employees to climb or change location without using fall protection (Exs. 0130, 0196; Tr. 576–579). NIOSH recommended "that fall protection equipment be used by all employees, including qualified employees, climbing or changing location on poles, towers, and other walking/working surfaces that present a potential fall hazard in both general industry and construction" (Ex. 0130). NIOSH supported its recommendation with a report that summarized surveillance data and investigative reports of fatal work-related falls from elevations (Ex. 0144). The first report noted that, according to National Traumatic Occupational Fatalities surveillance-system data, 23 percent of fatal falls in the transportation/communications/public utilities sector were from structures, predominantly poles and towers. This report provided detailed information about two fatalities involving employees performing work on poles or towers covered by this final rule:

- A power line worker died in a fall from a utility pole. As he was securing his positioning strap around the pole, he contacted a 120-volt conductor and fell as he tried to free himself from the conductor. He landed on his head and died of a broken neck.
- A painter died in a fall from an electric power transmission tower. As the employee unhooked his lanyard to reposition himself on the tower, he lost his balance and fell to the ground. He died of massive internal trauma sustained in the fall.

In both of these cases, NIOSH recommended evaluating the possibility of using 100-percent fall protection, including using fall protection while employees climb and relocate.

Lee Marchessault of Workplace Safety Solutions also recommended requiring fall protection for employees climbing or changing location on poles, towers, or similar structures, commenting:

> I have asked line workers in many companies if they have "cutout" (gaffs released and fallen to some extent from a pole).[141] The answer is almost universal, most (more than 90%) have cutout at lease once. The resulting injury is usually a nasty sliver from a treated wood pole or minor bruises or broken bones. This is a known hazard and yet it is allowed to continue even though there are devices that prevent this injury. This section should be eliminated from this regulation and replaced with "fall restraint devices are required from the ground for climbing poles or similar structures more than 6 feet and these devices shall be of a type that cannot be defeated where practicable". In other words, systems modifying existing pole straps, or pole mounted devices that need to be installed once you arrive would not be allowed because free-climbing is still or may still be done. Pole top mounted retractable devices protect from free fall but will not prevent slowly slipping down the pole picking up slivers from every gaff cut along the way. A system such as or similar to Buckingham's Bucksqueeze fall protection belt would meet this requirement. Regarding towers and structures, there is equipment or options available for most circumstances. [Ex. 0196]

Mr. Marchessault recognized, however, that there may be times when it is not feasible to provide protection and suggested that the standard account for those situations (Tr. 595).

Other rulemaking participants supported the proposed provision in paragraph (b)(3)(iii) that permitted qualified employees to free climb without fall protection. (See, for example, Exs. 0167, 0185, 0212.) For instance, Mr. John Vocke with Pacific Gas and Electric Company (PG&E) recommended that OSHA retain the exception allowing employees to free climb poles and towers, commenting:

> PG&E submits that the "free climbing" of utility poles and/or towers should continue to be permitted by the OSHA regulations. As more cable television, telephone and communication equipment is situated on utility poles, safe climbing space on these structures becomes a consideration. In order for line workers to access overhead electric facilities, in some instances, free climbing is a safer alternative. [Ex. 0185]

Whether to provide fall protection for employees climbing poles, towers, and similar structures was an issue in the 1994 § 1910.269 rulemaking. Participants in that rulemaking submitted substantial evidence on the need for, and feasibility of, providing such protection. Based on accident data submitted to that record in several exhibits, the Agency found that employees are at risk of injury when free climbing:

> [T]hese exhibits demonstrate that electric power generation, transmission, and distribution workers face a significant risk of serious injury due to falls under current industry practices. To determine the extent to which they face hazards addressed by proposed § 1910.269(g)(2)(v), OSHA analyzed fall accidents included in various exhibits contained in the rulemaking record. . . . [E]mployees do fall while climbing poles, towers, or similar structures—26 percent of the falling accidents related to § 1910.269 occurred in this manner. The evidence in the record indicates that climbing a pole, tower, or similar structure is not as safe, under current industry practices, as some of the hearing witnesses testified. Therefore, the

[141] A line worker using positioning equipment on a wood pole uses pole climbers, leg irons that are strapped to the worker's legs. A gaff, or spike, protrudes from the leg iron. The gaffs penetrate the wood of the pole and support the weight of the worker. A cutout occurs when the gaff slips out of the wood, allowing the worker to fall.

Agency has decided that the final standard must provide additional protection beyond that provided by the existing industry practices. . . . [59 FR 4373]

Although OSHA concluded that it was not always safe to free climb, the Agency "accepted the position that it is not always necessary for a qualified employee to use a pole strap when climbing an unstepped wooden pole" (*id.*) Therefore, in existing § 1910.269(g)(2)(v), OSHA adopted a rule, identical to that proposed in paragraph (b)(3)(iii), that allowed free climbing "unless conditions . . . could cause the employee to lose his or her grip or footing." OSHA believed that the rule adopted in § 1910.269 would ensure that employees were protected when conditions were most likely to lead to falls.

The Agency examined the accident information in the current record to determine if the rule in existing § 1910.269(g)(2)(v) has reduced climbing-related accidents. Table 3 presents relevant accident information from the 1994 record, and from the record in this rulemaking, to show the number of fall accidents occurring over time.

TABLE 3—FALLS BY YEAR

Type of fall [1]	Number of accidents [2]							
	1981–1989	1991–1993	1994	1995	1996	1997	1998	1999
Climbing [3]	11	15	3	5	2	3	1	3
At work location	7	5	0	0	0	0	0	1
Other (not stated)	3	0	0	0	0	0	0	0
Failure of Structure	12	6	0	0	1	2	0	2

Notes: 1. The table only includes falls from poles, towers, and similar structures.
2. Each accident involves the death or serious injury of one or more employees.
3. Climbing includes descending and changing location.
Sources: 1981–1989—Table 1 in the preamble to the 1994 § 1910.269 final rule (59 FR 4373).
1991–1999—Exs. 0003 and 0400.

The number of accidents in the years 1991 through 1999 are based on OSHA IMIS data. Because IMIS reports are based on investigations resulting from employer reports of accidents, and because employers are not required to report accidents that do not involve a fatality or the hospitalization of three or more employees, it is likely that IMIS data substantially undercount the number of nonfatal injuries. Even without adjusting for potential undercounting, however, the table shows that employees still face a significant risk of being severely injured in a fall while climbing poles, towers, or similar structures. In the 3 years before § 1910.269 was promulgated, employees climbing poles, towers, or similar structures experienced five accidents per year, on average. In the first 6 years after that standard was promulgated, there were approximately three accidents per year, on average, for a reduction of two accidents per year, on average.[142] This is in sharp contrast to the reduction in the number of falls experienced by employees at the work location on poles, towers, and similar structures. This type of accident has largely disappeared since OSHA issued § 1910.269.

In addition, more than a third of the falls experienced by employees climbing wood structures occurred when the employee's gaff cut out of the wood and caused the employee to fall to the ground (Exs. 0003, 0004). This is also the experience reported by Mr. Marchessault of Workplace Safety Solutions (Tr. 578). Federal and State compliance records reported that the poles involved in two of the gaff cutout accidents reflected in Table 3 had no observable defects (Ex. 0003[143]). Even though both of those accidents occurred before § 1910.269 was promulgated, it is likely that nothing in that standard would have prevented those accidents. Based on the comments, Mr. Marchessault's testimony, and the accident descriptions in the record, OSHA concludes that gaff cutout is pervasive, cannot be reliably predicted, and can lead to death or serious physical harm. (Mr. Marchessault described the injuries as "slivers" in his testimony, but injuries from gaff cutout accidents have included such serious injuries as severe fractures, a concussion, and a collapsed lung for which the injured employees were hospitalized (Exs. 0003, 0400).[144])

The current rule in § 1910.269 requires employers to protect employees from falling while climbing or changing location under specified circumstances, and evidence in this record indicates that in many, if not all, circumstances it is feasible for employees to climb and change locations while protected. For example, Mr. Marchessault of Workplace Safety Solutions testified that there are "equipment options available for most circumstances [involving employees climbing or changing location]" (Tr. 576); Mr. Steven Theis of MYR testified that he was aware that one utility required 100-percent fall protection (Tr. 1357); and IBEW noted that some employers require "fulltime attachment while climbing and working on a wood pole" [145] (Ex. 0230). According to an IBEW survey of 102 IBEW construction locals, more than a quarter of 93 locals responding to one question in the survey reported that "the employer require[s] continuous attachment to the pole when climbing," and nearly a third of 91 locals responding to another question reported that "the employer require[s] continuous attachment to the

[142] OSHA examined accident data for electric utilities for the years 2009 and 2010. In that industry alone, four employees were injured (three fatally) when they fell from structures supporting overhead power lines. (See the descriptions of these four accidents at: *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=202469680&id=202489316&id=201491990&id=201859964.*) In half the cases, the employees were climbing or changing location.

[143] See the descriptions of the two accidents at: *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=170374144&id=170611693.*

[144] OSHA also has documentation, not included in this analysis, of three instances in which employees were killed when they fell from utility poles as a result of gaff cutout (*http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=170252852&id=14422471&id=14412209*).

[145] OSHA concludes that, in describing the "climbing" of poles or structures, rulemaking participants used the term "climbing" broadly to indicate any employee movement, including "changing location," on poles or structures, as climbing a pole or structure to get to the working position involves the same horizontal and vertical movements as changing location vertically or horizontally on a pole or structure. OSHA also concludes that, in this context, rulemaking participants used the term "working" narrowly to indicate the activity of working in stationary positions on poles or structures and not broadly to also indicate the activity of climbing or changing location on poles or structures.

structure when climbing" (Ex. 0230). The preamble to the 1994 final rule for § 1910.269 noted that the Electrical Division of the Panama Canal Commission and Ontario Hydro in Canada required fall protection for their employees while they work on elevated structures (59 FR 4372–4373).

There are several new forms of work-positioning equipment that can provide continuous attachment for employees climbing or changing location on poles, towers, and similar structures. The preamble to the proposal noted the Pole Shark and Pole Choker (70 FR 34855).[146] Two commenters pointed to the BuckSqueeze as another work-positioning system that can provide continuous attachment while employees are climbing or changing location on wood structures (Ex. 0199; Tr. 578).[147] A video of this equipment being used demonstrates that an employee proficient in its use can ascend and descend poles with relative ease while being protected from falling (Ex. 0492). Rulemaking participants indicated that fall protection equipment is available to protect employees climbing or changing location on towers and similar structures (Exs. 0144, 0196). This equipment includes rail and rope-grab systems to which an employee can attach a harness and a lanyard, retractable lanyards attached above the employee, and double-lanyard systems (Ex. 0199; Tr. 578, 587[148]). OSHA believes that these, and similar new, devices make it easier to provide fall protection for employees climbing or changing location on poles, towers, and similar structures, as evidenced by the growing prevalence of employers requiring 100-percent attachment. Therefore, OSHA concludes that employees climbing or changing location on poles, towers, and similar structures can use fall protection under more conditions than required by existing § 1910.269(g)(2)(v).

However, OSHA also concludes that there may be circumstances that preclude the use of fall protection while employees are climbing or changing location. For example, Mr. James Tomaseski of IBEW testified, "[O]n congested poles, to be able to ascend the pole to your working area could be a major task in itself. On the congested poles it is enough of a task already, but adding to the point that you have to stay connected the entire time, it would be at best difficult" (Tr. 977). Mr. Theis of MYR Group echoed these concerns:

> [Employees] are using [pole chokers] now. And some of the guys are telling us they can't be used in all situations. In a lot of situations, they can be. When they start getting into a very congested pole, very congested area, they become more cumbersome than they are of any benefit. [Tr. 1357]

Consequently, OSHA decided to modify the provision proposed in paragraph (b)(3)(iii) (paragraph (b)(3)(iii)(C) in the final rule) to require fall protection even for qualified employees climbing or changing location on poles, towers, or similar structures, unless the employer can demonstrate that the conditions at the worksite would make using fall protection infeasible or would create a greater hazard for employees climbing or changing location on these structures while using fall protection. This rule will ensure that 100-percent fall protection is the default procedure when employees are working on these structures and, therefore, will better protect employees than the current requirement. Based on the rulemaking record, OSHA would consider it feasible to use fall protection while climbing or changing location on a structure with few or no obstructions. Employers may, however, make reasonable determinations of what conditions, for example, the degree of congestion on a pole, would result in a greater hazard for employees climbing with fall protection than without fall protection. Employers making these determinations must consider the use of devices that provide for continuous attachment and should account for other conditions that would make climbing or changing location without fall protection unsafe, including such conditions as ice, high winds, and the other conditions noted in existing § 1910.269(g)(2)(v). In addition, OSHA notes that this provision does not affect fall protection requirements in final § 1926.954(b)(3)(iii)(B) for employees once they reach the work location.

Because the final rule permits qualified employees to climb or change location without fall protection under limited circumstances, the Agency anticipates that it will be necessary for employees to occasionally defeat the continuous attachment feature on the fall protection equipment. Therefore, OSHA decided not to require the equipment used to meet paragraph (b)(3)(iii)(C) of the final rule to be incapable of being defeated by employees, as recommended by Mr. Marchessault (Ex. 0196).

Even though under existing § 1910.269(g)(2)(v) there already are some circumstances in which employers must provide equipment that will protect employees who are climbing or changing location on structures, OSHA believes that many employers covered by the final rule will need additional time to explore options to select equipment that best protects their employees while climbing or changing location. In some cases, the equipment employers currently are providing may not be ideal for everyday use. In addition, employers will need time to train employees to become proficient in the use of any new equipment. Before employees gain proficiency, it is possible that not only will they have difficulties climbing or changing location on structures, but the equipment may distract them from climbing or changing location safely. As noted by Mr. Gene Trombley, representing EEI in the 1994 rulemaking, "To suddenly try to require them to change years and years of training and experience would, I feel, cause a serious reduction in that high level of confidence and ability" (DC Tr. 853, as quoted in the preamble to the 1994 rulemaking, 59 FR 4372).[149] Therefore, OSHA is giving employers until April 1, 2015, to comply with the new requirements in § 1926.954(b)(3)(iii)(C) of the final rule. This delay should provide sufficient time for employers to: Evaluate the various types of fall protection equipment that employees climbing or changing location can use; select and purchase the type of equipment that best satisfies their needs; train employees in the use of this equipment; and certify that the employees demonstrated proficiency in using the equipment.

In the intervening period, paragraph (b)(3)(iii)(C) of the final rule will apply the existing rule from § 1910.269, which permits qualified employees to climb and change location without fall protection as long as there are no conditions, such as ice, high winds, the

[146] A Pole Shark is a device that uses jaws and a spur wheel to grip the pole and provide an anchorage for climbing wood poles. A Pole Choker is a pole strap with an integrated choker strap. The employee tightens the choker strap against the pole to prevent the pole strap from sliding down the pole. Note that, throughout this notice, references to these and other products are examples only and do not constitute an endorsement by OSHA.

[147] A BuckSqueeze is a pole strap with an integrated choker strap. The employee tightens the choker strap against the pole to prevent the pole strap from sliding down the pole.

[148] Mr. Marchessault described a double-strap system for use on a pole (Tr. 587). OSHA believes that employers can adapt this system, using lanyards in place of positioning straps, for use on a tower or similar structure.

[149] This transcript is available for inspection and copying in OSHA's Docket Office, Docket No. S–015, U.S. Department of Labor, 200 Constitution Avenue NW., Room N2625, Washington, DC 20210; telephone (202) 693–2350. (OSHA's TTY number is (877) 889–5627.) OSHA Docket Office hours of operation are 8:15 a.m. to 4:45 p.m., ET.

design of the structure (for example, no provision for holding on with hands), or the presence of contaminants on the structure, that could cause the employee to lose his or her grip or footing. The conditions specifically listed in the standard are not the only ones warranting the use of fall protection for climbing and changing position. Other factors affecting the risk of an employee's falling include the level of competence of the employee, the condition of a structure, the configuration of attachments on a structure, and the need to have both hands free for climbing. Moreover, if the employee is not holding onto the structure (for example, because the employee is carrying tools or equipment in his or her hands), the final rule requires fall protection. Video tapes entered into the 1994 § 1910.269 rulemaking record by EEI (269-Ex. 12–6), which EEI claimed represented typical, safe climbing practices in the utility industry, show employees using their hands to provide extra support and balance.[150] Climbing and changing location in this manner will enable an employee to continue to hold onto the structure in case his or her foot slips. When employees are not using their hands for additional support, they are much more likely to fall as a result of a slip.

All of these revisions, including the revisions related to fall protection for employees working from aerial lifts described earlier in this section of the preamble, appear in final § 1926.954(b)(3)(iii).

Paragraph (e)(1) of § 1926.502 limits the maximum free-fall distance for work-positioning systems to 0.6 meters (2 feet). OSHA proposed to adopt this same limit in § 1926.954. However, in electric power transmission and distribution work, permanent anchorages are not always available. Many utility poles provide no attachment points lower than the lowest crossarm. If an employee is working below the crossarm, there would be no place on the pole where he or she can attach the work-positioning equipment. The preamble to the proposed rule explained that, in such cases, work-positioning equipment still provides some degree of fall protection in that the equipment holds the employee in a fixed work position and keeps him or her from falling (70 FR 34855). Therefore, OSHA proposed in paragraph (b)(3)(iv) to require work-positioning equipment to be rigged so that the employee could free fall no more than 0.6 meters (2 feet), unless no anchorage was available. In the preamble to the proposed rule, OSHA requested comment on whether proposed paragraph (b)(3)(iv) would provide sufficient protection for employees and on whether portable devices (such as a Pole Shark, Pole Choker, or similar device) could be used as suitable anchorages.

Some commenters objected to the proposed requirement that work-positioning equipment be rigged with a maximum free fall of 0.6 meters (2 feet) insofar as it would apply when employees are working above equipment that could serve as an anchorage. (See, for example, Exs. 0201, 0230.) For instance, IBEW noted that an employee using work-positioning equipment might be much more than 0.6 meters above a potential attachment point, such as a neutral bolt (Ex. 0230). The union claimed that, if the employee used this attachment point, the free-fall distance would have to be more than 0.6 meters for the employee to reach the work.

OSHA acknowledges these concerns, but believes they can be eliminated by the use of portable devices. With portable devices, employees will not have to rely on anchorages on poles or structures because the employees would have anchorages that are part of the work-positioning equipment. Thus, it would always be possible to rig the equipment to accommodate a free fall of no more than 0.6 meters.

Many commenters opposed requiring portable devices to provide anchorages for employees on poles, towers, and similar structures. (See, for example, Exs. 0125, 0127, 0149, 0151, 0162, 0171, 0173, 0175, 0177, 0186, 0200, 0209, 0227.) Some of these commenters maintained that these devices do not meet the strength requirements for anchorages. (See, for example, Exs. 0177, 0227.) For instance, Mr. Thomas Taylor with Consumers Energy commented that "the specified portable devices do not meet the specifications for anchorages in Subpart M and were never designed to be used for that purpose" (Ex. 0177). Several commenters argued that these devices are not always effective, are difficult or impossible to use in some circumstances, are unnecessary, and could even increase the risk to employees. (See, for example, Exs. 0125, 0127, 0149, 0151, 0171, 0175, 0186, 0200.) For instance, Ms. Jill Lowe of the Employers Electrical and Communication Safety Committee of Washington and Oregon commented:

> The use of an anchorage device [such as] the pole shark, would not be an effective anchor when working on a structural member or sitting on a cross arm. The device would only be effective when climbing a pole without obstructions or working in a position on a pole below a cross arm or structural member. It must also be acknowledged that some of these devices could not physically be used due to limited space available on the pole at the work position (i.e.: Secondaries, crossarm braces, etc.) . . . .
>
> More information and data would be required before mandating the use of this type of equipment. For example, how many actual injuries have been recorded in a fall where a worker is belted in on the pole? Would this add weight or further encumber the worker when climbing the pole? These types of devices could be effective in severe ice conditions, but for day to day use, would not provide the desired efficacies and would impede climbing, add to maneuvering difficulties and could increase risk factor(s). [Ex. 0151]

Ms. Salud Layton of the Virginia, Maryland & Delaware Association of Electric Cooperatives argued that these devices pose a greater hazard because they increase "the amount of time spent on the pole, the complexity of the work performed on the pole, and the number of opportunities to make mistakes while doing unnecessary jobs not related to the original reason the pole was actually climbed" (Ex. 0175).

Mr. Anthony Ahern with the Ohio Rural Electric Cooperatives provided the following explanation for his argument that these devices can be difficult to use and could potentially increase the risk to employees:

> Some of these devices, especially the pole-shark, are large and very awkward to use. They are very difficult to maneuver into a narrow space and greatly limit movement on the pole. It is next to impossible for a lineman to turn around far enough with one of these devices to be able to reach the end of a ten foot cross arm or a davit arm or even work on a transformer bank mounted on a cluster rack. If two or more workers are working in the same area on a pole, these devices can really create a lot of interference. Also, quite often a second safety is required to be used with these devices so that the climber can transition past cables, cross arms or other equipment on a pole. This means an extra snap hook in the D-rings and increases the possibility of an accident because the lineman grabs the wrong one. These devices are also much more difficult to operate with rubber gloves on than a conventional safety strap. [Ex. 0186]

However, some commenters suggested that these types of devices could be used as anchorages. (See, for example, Ex. 0199; Tr. 1338, 1357.) A video submitted to the record shows one of these devices successfully supporting an employee who had fallen from a pole (Ex. 0492).

[150] Exhibits in the 1994 § 1910.269 rulemaking record (denoted as "269-Ex") also are available in Docket Number S–015.

OSHA concludes that the concerns of commenters who argued that portable anchorage equipment is difficult to use or poses increased hazards are unwarranted. As noted earlier, some employers already require 100-percent attachment. The testimony of Messrs. Marchessault (of Workplace Safety Solutions) and Theis (of MYR Group) offer evidence that Pole Sharks, Pole Chokers, and similar devices can be, and have been, used successfully as anchorages (Tr. 576–579, 1338, 1357). The videotape of one of these devices in use clearly demonstrates that the particular device is reasonably light and not significantly more difficult to use than the traditional positioning straps currently used by power line workers (Ex. 0492). Some of these devices occupy about the same space on a pole or structure as a positioning strap and, therefore, should fit wherever those straps fit (*id.*). Evidence also indicates that, with training, employees can use these devices proficiently (Ex. 0199; Tr. 576–579).

Mr. Ahern's example of an employee using positioning equipment to reach the end of a 3-meter (10-foot) crossarm supports the need for employees to use an anchorage at the work location. The end of the crossarm would be about 1.4 meters (4.6 feet) from the edge of the pole. To perform such work, a 2-meter-tall (6.5-foot-tall) employee would have to be in a nearly horizontal position to reach the end of the arm. This position increases the likelihood of gaff cutout, because the gaffs would be at an angle to the force applied by the employee's weight, which would be applied in a vertical direction. A gaff is designed to penetrate the wood when force is applied along its length. When force is applied perpendicular to the length of the gaff, it can twist the gaff out of the wood. In addition, to the extent it is impossible to reach the end of the crossarm with some of these devices, other methods of working from the pole can be used. For example, the employee could work from a pole-mounted platform, which would both enable the employee to reach further from the pole and provide an anchorage for the fall protection equipment (269-Ex. 8–5). Thus, the Agency concludes that there is greater need for an anchorage when work is performed in such positions.

The examples of working on a crossarm or a structural member provided by Ms. Lowe with the Employers Electrical and Communication Safety Committee of Washington and Oregon are inapposite. As noted earlier, work-positioning equipment is inappropriate for use in these situations; such equipment may be used only on vertical structural members. It is not clear why Pole Sharks, Pole Chokers, or similar devices, which are designed to supplement or replace traditional positioning straps, could not be used on vertical members in the same way a traditional positioning strap can be used.

OSHA concludes that the accident information in the record indicates that there is a need for employees to use an anchorage to keep them from falling while they are at the work location (Exs. 0002, 0400). Two of the gaff cutout accidents included in Table 3 occurred while an employee was at the work location. One commenter stated that one of his company's eight fall accidents occurred while an employee was at the work position (Ex. 0209). Although the total number of accidents is not great, these accidents are easily preventable.

The final rule, in paragraph (b)(3)(iii)(C), already requires employees to be protected while climbing. The same equipment that protects an employee climbing a pole can serve as an anchorage and can prevent him or her from falling while at the work location as well (Ex. 0492; Tr. 576–579). As a result, OSHA does not believe there will often be problems finding or providing anchorage points for work-positioning equipment that can satisfy the 0.6-meter maximum free-fall requirement.

The Agency notes that Consumers Energy incorrectly identified the relevant strength requirements for anchorages used with work-positioning equipment. Paragraph (b)(1)(i) of final § 1926.954 applies Subpart M only to fall arrest equipment. Paragraph (b)(3)(v) of final § 1926.954, described later in this section of the preamble, requires anchorages used with work-positioning equipment to be capable of supporting at least twice the potential impact load of an employee's fall, or 13.3 kilonewtons (3,000 pounds), whichever is greater. OSHA concludes that it is feasible with available technology for portable anchorage devices to meet the tensile-strength requirement in paragraph (b)(3)(v) of the final rule. The materials, including straps, buckles, rivets, snaphooks, and other hardware, that are, or could be, used in anchorages also are used in positioning straps for work-positioning equipment (Exs. 0055, 0492), which paragraph (b)(2)(vii)(C) of the final rule requires to have greater tensile strength than required by paragraph (b)(3)(v) of the final rule. In addition, Mr. Lee Marchessault with Workplace Safety Solutions testified about the experience of a line worker he had been training (Tr. 577–578). The line worker, who had been using a portable anchorage device (the BuckSqueeze) during the training exercise, experienced a gaff cutout, but was not injured because the device successfully arrested the fall (*id.*). The videotape Mr. Marchessault submitted for the record depicted this equipment as successfully arresting the fall of the worker who had been using it (Ex. 0492). Portable anchorage devices are designed to arrest an employee's fall into work-positioning equipment; thus, the devices almost certainly meet the strength requirements in ASTM F887–04, which, as noted earlier, are equivalent to OSHA's strength requirements for work-positioning equipment. In fact, the latest edition of the consensus standard, ASTM F887–12^{e1}, contains equivalent strength requirements for what it calls "wood pole fall restriction devices." [151] OSHA has included a note following paragraph (b)(3)(v) of the final rule to indicate that wood-pole fall-restriction devices meeting ASTM F887–12^{e1} are deemed to meet the anchorage-strength requirement when they are used in accordance with manufacturers' instructions.

For these reasons, paragraph (b)(3)(iv) in the final rule requires work-positioning systems to be rigged so that an employee can free fall no more than 0.6 meters (2 feet). OSHA is not including the proposed exemption for situations in which no anchorage is available. In view of the availability of wood-pole fall-restriction devices, OSHA expects that in most, if not all, circumstances, anchorages will not only be available, but will be built into work-positioning equipment to permit compliance with this provision, as well as paragraph (b)(3)(iii)(C) of the final rule. However, because the Agency believes that employers will purchase equipment that complies with both paragraphs (b)(3)(iii)(C) and (b)(3)(iv), OSHA is requiring compliance with both of these paragraphs starting on April 1, 2015. This delay should provide employers with sufficient time to evaluate, and then purchase, compliant equipment.

Final paragraph (b)(3)(v), which is being adopted without substantive change from the proposal, requires anchorages used with work-positioning equipment to be capable of sustaining at least twice the potential impact load of an employee's fall, or 13.3 kilonewtons (3,000 pounds), whichever is greater.

[151] Section 15.3.2 of ASTM F887–12^{e1} requires these devices, when new, to have a breaking strength of 13.3 kilonewtons (3,000 pounds). Section 24 of that standard describes test procedures for these devices to ensure that they will successfully arrest a fall.

This provision, which duplicates § 1926.502(e)(2), will ensure that an anchorage will not fail when needed to stop an employee's fall. Comments on the technological feasibility of this provision are addressed in the summary and explanation for paragraph (b)(3)(iv), earlier in this section of the preamble.

Final paragraph (b)(3)(vi), which is being adopted without substantive change from the proposal, provides that, unless a snaphook is a locking type and designed specifically for the following conditions, snaphooks on work-positioning equipment not be engaged to any of the following:

(1) Webbing, rope, or wire rope;

(2) Other snaphooks;

(3) A D ring to which another snaphook or other connector is attached;

(4) A horizontal lifeline; or

(5) 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.

This paragraph, which duplicates § 1926.502(e)(8), prohibits methods of attachment that are unsafe because of the potential for accidental disengagement of the snaphooks during use.

6. Section 1926.955, Portable Ladders and Platforms

Final § 1926.955 addresses portable ladders and platforms. Paragraph (a) provides that requirements for portable ladders used in work covered by Part 1926, Subpart V are contained in Part 1926, Subpart X, except as noted in § 1926.955(b). Proposed paragraph (a) also provided that the requirements for fixed ladders in subpart D of part 1910 (§ 1910.27) applied to fixed ladders used in electric power transmission and distribution construction work. OSHA is including proposed paragraph (a) in the final rule with one change—deleting the second provision.

Fixed ladders used in electric power generation, transmission, and distribution work are permanent ladders. They are the same ladders irrespective of whether the work being performed on them is construction work covered by subpart V or maintenance work covered by § 1910.269. In the preamble to the proposal, OSHA explained that the Agency believed that the Part 1910, Subpart D standards should apply to these ladders during construction, as well as during maintenance work (70 FR 34855), but requested comments on whether the proposed incorporation of the general industry standard for fixed ladders was warranted, especially in light of the 1990 proposed revision to Part 1910, Subpart D (55 FR 13360, Apr. 10, 1990). OSHA recently reproposed the revision of that subpart (75 FR 28862, May 24, 2010).

A few commenters responded to this issue. (See, for example, Exs. 0162, 0212, 0227, 0230.) Southern Company was concerned about the proposed incorporation of Subpart D, commenting:

> We question the use of 1910.27 for fixed ladders since OSHA proposed the revision of this standard over 15 years ago and there has been no action to date. Due to the time that has elapsed since OSHA published the proposed revisions to 1910 Subpart D and the revisions that have been made to the national consensus standards for all types of ladders, OSHA may wish to consider reopening the rulemaking prior to proceeding with the revisions to Subpart D. We recommend that OSHA not reference Subpart D as a part of the revisions to Subpart V and 1910.269 until work on the revision to Subpart D is completed. [Ex. 0212]

Southern Company also asked OSHA to explain "why the provisions of 1910 Subpart D should be applied to fixed ladders instead of the fixed ladder requirements of 1926.1053" (*id.*). Southern Company asserted that the construction standard contained requirements that are not found in the general industry standard, but that contribute to employee safety (*id.*).

EEI recommended that neither § 1926.955(a) nor the corresponding provision in the general industry standard, § 1910.269(h)(1), incorporate part 1910, subpart D by reference until OSHA finalizes revisions to part 1910, subpart D (Ex. 0227). EEI asserted that there were discrepancies between the requirements for fixed ladders in existing part 1910, subpart D, the 1990 proposed part 1910, subpart D, and the then-current ANSI standard for fixed ladders, ANSI A14.3–2002, *American National Standard for Ladders—Fixed—Safety Requirements* (*id.*). EEI also asserted that the existing general industry standard contained outdated design requirements (*id.*).

OSHA accepts EEI's and Southern Company's recommendation not to apply the requirements for fixed ladders in § 1910.27 to fixed ladders used in the construction of electric power transmission and distribution installations, though not for the reasons these commenters stated. OSHA believes that the use of fixed ladders in the construction of transmission and distribution installations is not unique. As such, the requirements that apply to fixed ladders in the construction of electric power transmission and distribution installations should be the same as the requirements that apply generally to construction work (including, as Southern Company noted, the requirements contained in § 1926.1053).

Because OSHA is not including the cross-reference to subpart D for fixed ladders in the final rule and because the remaining provisions in § 1926.955(a) apply only to portable ladders and platforms, OSHA is revising the title of § 1926.955 to "Portable ladders and platforms" to more accurately reflect the contents of this section.

OSHA also accepts EEI's and Southern Company's recommendation not to reference in final § 1910.269(h) the part 1910, subpart D provisions for fixed ladders because, as with final § 1926.955, § 1910.269(h) in the final rule covers only portable ladders and platforms. Therefore, OSHA is revising the title of § 1910.269(h) to "Portable ladders and platforms" and is revising the regulatory text of final § 1910.269(h)(1) to clarify that the paragraph applies to portable ladders and platforms, not fixed ladders. These changes make final § 1910.269(h) consistent with final § 1926.955.

MYR Group also had concerns about applying the general industry standards to construction work. MYR Group maintained that contractors would have little control over fixed ladders provided by host employers (Ex. 0162).

The Agency notes that an employer whose employees are performing the work must adhere to OSHA standards. If, for example, an electric utility's fixed ladder does not comply with Part 1926, Subpart X, then a contractor whose employees would be using that ladder must take whatever measures are necessary to protect its employees and comply with Part 1926, Subpart X. Such measures include enforcing any contractual language requiring the utility to address any noncompliant ladders, using other means of accessing the work area, such as portable ladders or aerial lifts, and repairing or replacing the ladder.

IBEW recommended that OSHA consider the specifications for fixed ladders in IEEE Std 1307, *Standard for Fall Protection for Utility Work,* when finalizing the language for subpart V and § 1910.269 (Ex. 0230).The union wrote:

> [T]he committee responsible for developing the standard went through great pains to research ladders, step bolts, and other climbing devices commonly installed on electrical structures. Lineman climbing boots and other equipment was looked at for the purpose of establishing ladder and step

bolt criteria that would be compatible with the worker safety equipment. [Ex. 0230]

OSHA rejects IBEW's recommendation to adopt requirements based on IEEE Std 1307. Although that consensus standard contains requirements for structures found in electric power generation, transmission, and distribution work (for example, utility poles and towers), those structures are not unique to the electric power industry; and the Agency believes, therefore, that this rulemaking is not the proper vehicle to regulate them. The same types of structures are found in other industries, in particular, the telephone and cable-television industries. Utility poles and towers are used to support telephone lines, cable television lines, communications antennas, and other equipment used by these industries. OSHA notes that its recently proposed revision of part 1910, subpart D includes requirements for fixed ladders on towers and for step bolts on towers and poles (see proposed § 1910.24, Step bolts and manhole steps; 75 FR 29136).

Paragraph (b) of the final rule establishes requirements for special ladders and platforms used for electrical work. Because the lattice structure of an electric power transmission tower and overhead line conductors generally do not provide solid footing or upper support for ladders, OSHA is exempting portable ladders used on structures or conductors in conjunction with overhead line work from the general provisions of § 1926.1053(b)(5)(i) and (b)(12), which address ladder support and the use of ladders near exposed electric equipment. As noted in the preamble to the proposal, an example of a type of ladder exempted from these provisions is a portable hook ladder used by power line workers to work on overhead power lines (70 FR 34855).[152] These ladders are hooked over the line or other support member and then are lashed in place at both ends to keep them steady while employees are working from them.

Final paragraphs (b)(1) through (b)(4) and (c) provide employees with protection that is similar to the protection afforded to employees by § 1926.1053(b)(5)(i) and (b)(12). These provisions require that these special ladders and platforms be secured, specify the acceptable loads and proper strength of this equipment, and provide that the ladders be used only for the particular types of application for which they are designed. These provisions thereby ensure that employees are adequately protected when using the ladders covered by the final rule. In the § 1910.269 rulemaking, OSHA concluded that these alternative criteria provide for the safe use of this special equipment, and the Agency is extending the application of these alternative criteria to work covered by Subpart V (59 FR 4375). It should be noted that the requirements for portable ladders in final paragraphs (b)(1) through (b)(4) apply in addition to requirements in § 1926.1053 for portable ladders. OSHA revised the language in the final rule to clarify that the requirements in § 1926.1053, except for paragraph (b)(5)(i) and (b)(12), apply to portable ladders used on structures or conductors in conjunction with overhead line work and that the requirements in paragraphs (b)(1) through (b)(4) apply only to portable ladders and platforms used in this manner.

Paragraph (b)(1) of final § 1926.955 requires portable platforms to be capable of supporting without failure at least 2.5 times the maximum intended load in the configurations in which they are used. Paragraph (b)(1) in the proposed rule also applied this requirement to portable ladders. However, § 1926.1053(a)(1), which also applies, already specifies the strength of portable ladders. Having two standards with different strength requirements for portable ladders would be confusing. Consequently, OSHA revised § 1926.955(b)(1) in the final rule so that it covers only portable platforms.

Paragraph (b)(2) of final § 1926.955 prohibits portable ladders and platforms from being loaded in excess of the working loads for which they are designed. It should be noted that, with respect to portable ladders, compliance with this provision constitutes compliance with § 1926.1053(b)(3).

Paragraph (b)(3) of final § 1926.955 requires portable ladders and platforms to be secured to prevent them from becoming accidentally dislodged.[153] Accordingly, with respect to portable ladders, OSHA concludes that compliance with § 1926.955(b)(3) constitutes compliance with § 1926.1053(b)(6), (b)(7), and (b)(8).[154]

Paragraph (b)(4) of final § 1926.955 requires portable ladders and platforms to be used only in applications for which they are designed. It should be noted that, with respect to portable ladders, compliance with this provision constitutes compliance with § 1926.1053(b)(4).

Paragraph (c) prohibits the use of portable metal, and other portable conductive, ladders near exposed energized lines or equipment. This paragraph addresses the hazard to employees of contacting energized lines and equipment with conductive ladders. However, as noted in the preamble to the proposal, in specialized high-voltage work, the use of nonconductive ladders could present a greater hazard to employees than the use of conductive ladders (70 FR 34855–34856). In some high-voltage work, voltage can be induced on conductive objects in the work area. When the clearances between live parts operating at differing voltages, and between the live parts and grounded surfaces, are large enough that it is relatively easy to maintain the minimum approach distances required by § 1926.960(c)(1), electric shock from induced voltage on objects in the vicinity of these high-voltage lines can pose a greater hazard. Although these voltages do not normally pose an electrocution hazard, the involuntary muscular reactions caused by contacting objects at different voltages can lead to falls. Using a conductive ladder in these situations can minimize the voltage differences between objects within an employee's reach, thereby reducing the hazard to the employee. Therefore, the final rule permits a conductive ladder to be used if an employer can demonstrate that the use of a nonconductive ladder would present a greater hazard to employees.

7. Section 1926.956, Hand and Portable Power Equipment

Final § 1926.956 addresses hand and portable power equipment. The title of this section in the proposal was "Hand and portable power tools." OSHA revised the title to comport with the scope of the requirements in this section, which address equipment generally and not just tools. Paragraph

[152] Existing § 1926.1053(b)(12) provides that "[l]adders shall have nonconductive siderails if they are used where the employee or the ladder could contact exposed energized electrical equipment, except as provided in § 1926.951(c)(1) of this part." In this final rule, OSHA is replacing the reference to § 1926.951(c)(1) with a reference to the corresponding provision in the final rule, § 1926.955(c), and to final § 1926.955(b), which exempts special ladders used for electrical work from the requirement for nonconductive siderails.

[153] It should be noted that, to meet paragraph (b)(3), employers must ensure that portable ladders and platforms are always secured when in use, regardless of the conditions of the surface on which the ladder is placed. For example, when a conductor platform, such as a cable cart, is suspended from a line conductor by a trolley or hooks, the platform must be secured to the conductor so that it cannot fall if the trolley or hooks become dislodged.

[154] It should also be noted that § 1926.1053(b)(1), which requires that portable ladders be secured in certain situations, applies additional requirements when portable ladders are used to access an upper landing surface. Therefore, compliance with final § 1926.955(b)(3) does not constitute compliance with these requirements.

(a) of this section of the final rule provides that electric equipment connected by cord and plug is covered by paragraph (b), portable and vehicle-mounted generators used to supply cord- and plug-connected equipment are governed by paragraph (c), and hydraulic and pneumatic tools are covered by paragraph (d). OSHA took all of the requirements in this section from existing § 1910.269(i).

Electric equipment connected by cord and plug must satisfy the requirements in paragraph (b). Proposed paragraph (b)(1) stated that cord- and plug-connected equipment supplied by premises wiring is covered by Subpart K of Part 1926. OSHA is not including this proposed requirement in the final rule because, first, OSHA determined that the language in proposed paragraph (b) improperly emphasized "premises wiring." The purpose of the proposed provision was to clarify that equipment covered by Subpart K would continue to be covered by that Subpart (70 FR 34856). However, OSHA derived the proposed provision from the corresponding provision in existing § 1910.269(i). That provision was, in turn, derived from § 1910.302(a)(1), which specifies the scope of part 1910, subpart S, and provides that the subpart's "design safety standards for electric utilization of systems" apply to "electrical installations and utilization equipment installed or used within or on buildings, structures, and other premises" (that is, premises wiring). Section 1926.402, which specifies the scope of Subpart K, does not use the term "premises wiring." Second, proposed § 1926.956(b)(1), and its counterpart in existing § 1910.269(i)(2)(i), are unnecessary because these provisions simply refer to requirements that already apply. Therefore, to remove any ambiguity, the Agency is not including proposed § 1926.956(b)(1) in the final rule and is removing existing § 1910.269(i)(2)(i) and is replacing the reference in existing § 1910.269(i)(2)(ii) (final § 1910.269(i)(2)) to any cord- and plug-connected equipment supplied by other than premises wiring with a reference to cord- and plug-connected equipment not covered by Subpart S.

Pursuant to proposed paragraph (b)(2), equipment not covered by subpart K had to have the tool frame grounded, be double insulated, or be supplied by an isolating transformer with an ungrounded secondary. The proposed rule (and existing § 1926.951(f)(2)(iii)) did not specify any limit on the secondary voltage of the isolating transformer. OSHA is promulgating this paragraph in the final rule (final paragraph (b)(3)) with one substantive change—if an isolating transformer with an ungrounded secondary is used to comply with this provision, its secondary voltage is limited to 50 volts.

In the preamble to the proposed rule, OSHA noted the widespread availability of double-insulated tools and requested comment on whether the option permitting tools to be supplied through an isolating transformer was still necessary (75 FR 34856). Several commenters responded to this request. (See, for example, Exs. 0126, 0186, 0201, 0209, 0212, 0213, 0227, 0230.)

Most of these comments supported retaining the proposed option that permits cord- and plug-connected equipment to be supplied by an isolating transformer. (See, for example, Exs. 0201, 0209, 0212, 0213, 0227.) For instance, Duke Energy stated: "OSHA should continue to allow the third option of isolating transformers. While most applications are covered by grounding or double insulating, there are unique situations where neither of these is possible and an isolating transformer may be necessary to protect employees" (Ex. 0201). TVA commented, without elaboration, that "[d]uring plant outages there are situations where the use of isolating transformers provides the best employee safety" (Ex. 0213). Southern Company relied on OSHA's statement in the preamble to the proposal [155] that using isolating transformers is "an effective means of protecting employees from shock" (Ex. 0212).

Other commenters asserted that using isolating transformers was an outdated form of protection. (See, for example, Exs. 0126, 0186, 0230.) For instance, Mr. Anthony Ahern of Ohio Rural Electric Cooperatives wrote:

> Isolating transformers are not needed today. Almost all tools today are either double insulated or equipped with a grounding (3 wire) cord and plug. OSHA already has rules which cover the use and maintenance of these types of tools. Further, battery operated and gas powered tools are becoming more and more common and hydraulic tools are commonly used with bucket trucks. [Ex. 0186]

IBEW commented, "Double insulated hand tools are the industry standard. It would be difficult to find tools that are not double insulated or the tool frame is not grounded" (Ex. 0230). IBEW stated, however, that isolating transformers continue to be an option "[i]f other types of tools continue to be used" (*id.*).

[155] See 70 FR 34856.

OSHA determined that the proposed option permitting cord- and plug-connected equipment to be supplied by an isolating transformer was insufficiently protective and that this option will only provide sufficient protection against ground faults when the isolation transformer has an ungrounded secondary of no more than 50 volts. OSHA is imposing the 50-volt limit on isolation transformers because, although OSHA stated in the preamble to the proposal that each of the three options (grounding, double insulation, and isolation) provided protection from electric shock (70 FR 34856), OSHA recognized in other standards the limited protection provided by isolating transformers.[156] If unlimited voltages are permitted with respect to the isolating transformer option, employees working with cord- and plug-connected equipment operating at higher voltages would be exposed to a serious electric-shock hazard when a second ground fault occurs. Even if equipment is supplied by an isolating transformer with an ungrounded secondary, there will always be a path to ground for the circuit conductors. This path will be caused by leakage or by capacitive or inductive coupling. Depending on the location of this path, one of the circuit conductors could have a voltage to ground as high as the full circuit voltage. Thus, while the corresponding electrical standards for general industry and construction at §§ 1910.304(g)(6)(vi) and (g)(6)(vii) and 1926.404(f)(7)(iv), respectively, permit all three options, the standards (in §§ 1910.304(g)(6)(vii)(A) and 1926.404(f)(7)(iv)(C)(*6*)) also limit the secondary voltage on the isolating transformer to 50 volts or less. Fifty volts or less is widely recognized as a generally safe voltage. (See, for example, Exs. 0076, 0077, 0532.)

Paragraph (c) of final § 1926.956 requires portable and vehicle-mounted generators used to supply cord- and plug-connected equipment covered by paragraph (b) to meet several requirements. Under paragraph (c)(1), the generator may only supply equipment on the generator or the vehicle (for example, lights mounted on the generator or vehicle) and cord- and plug-connected equipment through receptacles mounted on the generator or the vehicle. Paragraph (c)(2) provides that non-current-carrying metal parts of

[156] OSHA notes that TVA did not address the safety of using an isolating transformer with a secondary voltage of more than 50 volts during a plant outage. However, pursuant to the final rule, if TVA uses such a transformer during a plant outage or otherwise, that transformer must have a secondary voltage of not more than 50 volts.

equipment, and the equipment grounding conductor terminals of the receptacles, must be bonded to the generator frame. Paragraph (c)(3) requires that the frame of vehicle-mounted generators be bonded to the vehicle frame. Finally, paragraph (c)(4) requires the neutral conductor to be bonded to the generator frame. The final rule clarifies that these requirements apply only when Subpart K does not apply, as explained in the discussion of § 1926.956(b), earlier in this section of the preamble. The requirements in this paragraph are similar to the corresponding Subpart K requirements, which are contained in § 1926.404(f)(3).

Final paragraph (d), which is being adopted without substantive change from the proposal, applies to pneumatic and hydraulic tools. Paragraph (d)(1) of § 1926.302 requires the fluids used in hydraulic-powered tools to be fire resistant. As explained in the preamble to the proposed rule, insulating hydraulic fluids are not inherently fire resistant, and additives that could make them fire resistant generally make the hydraulic fluid unsuitable for use as insulation (70 FR 34856). Because of these characteristics and because hydraulic fluids must be insulating to protect employees performing power transmission and distribution work, existing § 1926.950(i) exempts insulating hydraulic fluids from § 1926.302(d)(1).

OSHA proposed to continue this exemption in § 1926.956(d)(1), but was concerned by several accidents described in the record that occurred when insulating hydraulic fluid ignited and burned employees (Ex. 0002). The Agency requested information on whether fire-resistant insulating hydraulic fluids were available or were being developed.

OSHA did not receive any information about the availability or progress with the development of fire-resistant insulating hydraulic fluid; consequently, OSHA is including the existing exemption for insulating hydraulic fluids in the final rule. The Agency believes that the most serious hazard faced by an employee performing work covered by subpart V is electric shock. The Agency also reviewed the accidents in the record (such as Exs. 0002, 0003, 0004, and 0400) and concluded that, although insulating hydraulic fluid poses a substantial risk of igniting and burning workers, the risk of electric shock with uninsulated hydraulic equipment poses a greater risk of harm. OSHA encourages employers and manufacturers to develop insulating fluid that also is fire-resistant and will reexamine this issue if such fluids become available.

Final paragraph (d)(2) provides that safe operating pressures may not be exceeded. This requirement protects employees from the harmful effects of tool failure. If hazardous defects are present, no operating pressure would be safe, and the tools could not be used. In the absence of defects, the maximum rated operating pressure (which may be specified by the manufacturer or by hydraulics handbooks) is the maximum safe pressure. OSHA included a note to this effect in the final rule.

If a pneumatic or hydraulic tool is used where it may contact exposed energized parts, the tool must be designed and maintained for such use under final paragraph (d)(3). In addition, under paragraph (d)(4), hydraulic systems for tools that may contact exposed live parts during use must provide protection against loss of insulating value, for the voltage involved, due to the formation of a partial vacuum in the hydraulic line. Under paragraph (d)(5), a pneumatic tool used on energized electric lines or equipment or used where it may contact exposed live parts must provide protection against the accumulation of moisture in the air supply. These three requirements protect employees from electric shock by restricting current flow through hoses.

OSHA included a note following paragraph (d)(4) of the final rule addressing the use of hydraulic lines that do not have check valves.[157] If such lines are located in such a manner that the highest point on the hydraulic system is more than 10.7 meters (35 feet) above the oil reservoir, a partial vacuum can form inside the line. A partial vacuum can cause a loss of insulating value, possibly resulting in an electrical fault and consequent hydraulic system failure while an employee is working on a power line. During the rulemaking on the 1994 § 1910.269 final rule, IBEW reported two accidents that resulted from such an occurrence (269–DC Tr. 613). Therefore, OSHA inserted the note when the Agency adopted existing § 1910.269(i)(4)(iii), which is mirrored in final § 1926.956(d)(4).[158]

Final paragraphs (d)(6) and (d)(7) provide work-practice requirements to protect employees from the accidental release of pressure and from the injection of hydraulic oil (which is under high pressure) through the skin and into the body. The first of these two provisions requires the release of pressure before connections in the lines are broken, unless quick-acting, self-closing connectors are used. In the case of hydraulic tools, the spraying hydraulic fluid itself, which is flammable, poses additional hazards. Final paragraph (d)(7) requires employers to ensure that employees do not use any part of their bodies, such as a finger, to try to locate or stop a hydraulic leak. This provision in the final rule has been reworded to clarify that the employer has responsibility for compliance.

Final paragraph (d)(8) provides that hoses not be kinked. Kinks in hydraulic and pneumatic hoses can lead to premature failure of the hose and to sudden loss of pressure. If this loss of pressure occurs while the employee is using the tool, an accident could result in harm to employees. For example, a hydraulic or pneumatic tool supporting a load could drop the load onto an employee on a sudden loss of pressure.

NIOSH suggested that OSHA "consider an additional safeguard against the unintentional release of hydraulic oil—the use of hoses that are color coded by the [operating pressure] they can withstand, thus reducing the hazard of skin absorption or fire" (Ex. 0130). NIOSH did not submit any evidence that employers are using hoses of improper rating on hydraulic equipment. Consequently, the Agency is not adopting a requirement to color code hydraulic hoses according to safe operating pressure. However, NIOSH submitted evidence that an employer performing maintenance on an insulating hydraulic tool improperly replaced a nonconductive hose with a hose that was conductive because of its metal reinforcement (Ex. 0139). Although OSHA is not adopting a color-coding requirement in the final rule, the Agency advises manufacturers to clearly distinguish between conductive and nonconductive hoses.

Section 1926.957, Live-Line Tools

Final § 1926.957 is equivalent to existing § 1910.269(j) and contains requirements for live-line tools (some of which are commonly called "hot sticks"). This type of tool is used by qualified employees to handle energized conductors. The tool insulates the employee from the energized line. For example, a wire tong, which is a slender insulated pole with a clamp on one end, is used to hold a conductor at a distance while work is being performed. Common types of live-line tools include

[157] A check valve blocks reverse flow of the hydraulic fluid and prevents the formation of a partial vacuum.

[158] OSHA notes that whether a partial vacuum will result in the loss of insulating value that triggers actions to prevent the formation of a partial vacuum depends on the voltage involved.

wire tongs, wire-tong supports, tension links, and switch, fuse, and tie sticks.

Mr. Leo Muckerheide of Safety Consulting Services was concerned that proposed § 1926.957 did not address all types of live-line tools, stating:

> There is no definition given for a live-line tool except in the preamble. It states that such a tool is used to handle energized conductors and then gives some examples. There are other work practices, such as installing personal protective grounds, checking for voltage, pulling fuses or cutouts, removing or installing pins on suspension insulators, removing or installing jumpers, etc., where an insulated tool (switch/fuse/hot stick) is utilized. The insulating characteristics of these insulated tools (switch/fuse/hot stick) is critical to the accomplishment of such activities without injury to the worker. Any insulated tool (switch/fuse/hot stick) that is used on an energized circuit or a normally energized circuit in a manner that places a part of the tool inside the minimum approach distance . . . should be considered a live-line tool. The worker is depending on the insulating characteristics of the tool for protection. [Ex. 0180]

He recommended that OSHA expand this section to include these other insulated tools (*id.*).

OSHA notes that the lists of live-line tools provided here and in the preamble to the proposal (70 FR 34853) are not exhaustive. Also, OSHA added some of Mr. Muckerheide's examples to the list in the first paragraph of the summary and explanation for final § 1926.957. Final § 1926.957, and its general industry counterpart, final § 1910.269(j), cover any tool that is designed to contact an energized part and insulate the worker from that part. IEEE Std 516–2003, *IEEE Guide for Maintenance Methods on Energized Power Lines,* defines "insulating tool or device" as a tool or device "designed primarily to provide insulation from an energized part or conductor" (Ex. 0041).[159] This definition is consistent with OSHA's use of the term "live-line tool." The Agency believes that the term is well understood by the regulated community and that the guidance provided in this preamble makes the Agency's meaning of the term clear. Therefore, OSHA concludes that it is not necessary to define "live-line tool" in the final rule.

Paragraph (a), which is being adopted without change from the proposal, requires live-line tool rods, tubes, and poles to be designed and constructed to withstand 328,100 volts per meter (100,000 volts per foot) for 5 minutes if made of fiberglass-reinforced plastic (FRP), 246,100 volts per meter (75,000 volts per foot) for 3 minutes if made of wood, or other tests that the employer can demonstrate are equivalent. The voltage per unit length varies with the type of material because different insulating materials are capable of withstanding different voltages over equal lengths. For example, a higher design standard for wood would cause most wood to fail to meet the specification, while a lower design specification would allow substandard products into service. Since the withstand voltages in final paragraph (a) are consistent with the withstand voltages in existing § 1910.269(j)(1) and ASTM F711–02 (2007), *Standard Specification for Fiberglass-Reinforced Plastic (FRP) Rod and Tube Used in Live-Line Tools,* OSHA expects that tools currently in use in the industry will continue to be acceptable. A note in the final regulatory text provides that tools that meet ASTM F711–02 (2007) will be deemed to comply with paragraph (a)(1) of final § 1926.957. Together with the minimum approach distances in § 1926.960(c)(1), final paragraph (a) of § 1926.957 protects employees from electric shock when they are using these tools.

Mr. Frank Owen Brockman with Farmers Rural Electric Cooperative Corporation recommended that the standard not contain provisions for live-line tools made of wood (Ex. 0173). He maintained that these tools are outdated and should no longer be in service (*id.*).

OSHA believes that wood live-line tools likely are no longer in service and are no longer being manufactured. However, the Agency has no evidence in the record that there are no wood live-line tools currently in service. As long as they meet the requirements in final § 1926.957, they can effectively protect employees from electric shock. Therefore, OSHA is including in the final rule without change the proposed requirements for live-line tools made of wood.

Paragraph (b) addresses the condition of tools. The requirements in this paragraph duplicate the requirements in existing § 1910.269(j)(2) and will ensure that live-line tools remain in a safe condition after they are put into service. Paragraph (b)(1), which is being adopted without change from the proposal, requires live-line tools to be wiped clean and visually inspected for defects before each day's use. Wiping the tool removes surface contamination that could lower the insulating value of the tool. Inspecting the tool will identify any obvious defects that could also adversely affect the insulating value of the tool.

Paragraph (b)(2), which is being adopted without change from the proposal, provides that a tool be removed from service if any contamination or defect that could adversely affect its insulating qualities or mechanical integrity is present after the tool is wiped clean. This paragraph protects employees from the failure of live-line tools during use. Tools removed from service must be examined and tested under final paragraph (b)(3) before being returned to service.

During the rulemaking on existing § 1910.269, OSHA found that, while there was no evidence in the record of any injuries related to the failure of a hot stick, evidence did indicate that these tools have failed in use (without injury to employees) and that employees depend on their insulating value while using them to handle energized conductors (59 FR 4378). The Agency believes that live-line tools are not typically used to provide protection for employees in the rain (when work is normally suspended), which probably accounts for the lack of injuries in the record.[160] However, live-line tools might be used under wet conditions, in which case it is necessary to ensure that these tools will retain their insulating qualities when they are wet. In addition, employee safety is dependent on the insulating integrity of the tool—failure of a live-line tool would almost certainly lead to serious injury or death whenever the tool is the only insulating barrier between the employee and a live part. Therefore, OSHA is adopting rules on the periodic examination and testing of live-line tools to ensure that the live-line tools employees use are safe.

Although visual inspection can detect the presence of hazardous defects and contamination, the Agency concluded, on the basis of the 1994 rulemaking record for existing § 1910.269, that the daily inspections required by final paragraph (b)(1) might not detect all defects and contamination (59 FR 4378). Referring to live-line tools that had failed in use, a Georgia Power Company study submitted to that 1994 rulemaking record stated: "Under visual inspection all the sticks appeared to be relatively clean with no apparent surface irregularities" (269-Ex. 60). These tools passed a dry voltage test, but failed a wet voltage test.[161] While the study

[159] IEEE Std 516–2009 contains the same definition (Ex. 0532).

[160] A contaminated tool will fail more easily when wet than when dry (Ex. 0532). Tools are supposed to be wiped before use, in part to remove moisture.

[161] A so-called "dry test" of a live-line tool is an electrical test performed on the tool after it is stored under ambient, low-humidity, test conditions for 24 hours. A so-called "wet test" is an electrical test performed on the tool after the tool is placed in a

further noted that the surface luster on the sticks was reduced, apparently the normal visual inspection alone did not detect the defects that caused those tools to fail.

To address these concerns, OSHA is adopting requirements in paragraph (b)(3) for the thorough examination, cleaning, repair, and testing of live-line tools on a periodic basis. These provisions are adopted in the final rule without substantive change from the proposal. The tools must undergo this process on a 2-year cycle and whenever the tools are removed from service on the basis of the daily inspection.[162]

The final rule first requires a thorough examination of the live-line tool for defects (paragraph (b)(3)(i)). After the examination, the tool must be cleaned and waxed if no defects or contamination are found; if a defect or contamination that could adversely affect the insulating qualities or mechanical integrity of the live-line tool is found during the examination, the tool must be repaired and refinished or permanently removed from service as specified by final paragraph (b)(3)(ii). In addition, under final paragraph (b)(3)(iii), a tool must be tested: (1) After it has been repaired or refinished, regardless of its composition; or (2) after an examination is conducted in accordance with final paragraph (b)(3)(i) that results in no repair or refinishing being performed (although no testing is required if the tool is made of FRP rod or foam-filled FRP tube and the employer can demonstrate that the tool has no defects that could cause it to fail in use).

In accordance with final paragraph (b)(3)(iv), the test method used must be designed to verify the tool's integrity along its full working length and, if the tool is made of FRP, its integrity under wet conditions. The performance criteria specified by final paragraph (a) are "design standards" that must be met by the manufacturer. The test voltages and test duration used during the manufacturing process are not appropriate for periodic retesting of the hot sticks because live-line tools may sustain damage during such tests. Accordingly, the in-service tests required by final paragraph (b)(3)(v) are designed to assure as much employee protection as possible without damaging the tools. For tools with both hollow and foam-filled sections, the filled section is typically considered to constitute the insulating portion of the tool, which, for the purposes of final paragraph (b)(3)(iv), is the working length of the tool.

Under final paragraph (b)(3)(v), the test voltages must be 246,100 volts per meter (75,000 volts per foot) for fiberglass tools or 164,000 volts per meter (50,000 volts per foot) for wood tools, and, in both cases, the voltage must be applied for 1 minute. Other tests are permitted if the employer can demonstrate that they provide equivalent employee protection.

A note to paragraph (b) of the final rule states that guidelines for the inspection, care, and testing of live-line tools are specified in IEEE Std 516–2009.

Mr. Stephen Frost with Mid-Columbia Utilities Safety Alliance commented that the IEEE standard does not contain test criteria for FRP tools with hollow sections, but supported OSHA's proposal to adopt the same language as existing § 1910.269 (Ex. 0184).

OSHA reviewed the test procedures in IEEE Std 516–2009 and found that they do address hollow, as well as foam-filled, live-line tools. The Agency believes that these tests can be used by the employer as appropriate for the different sections of multiple-section tools.

Mr. Leo Muckerheide of Safety Consulting Services commented that existing § 1910.269(j)(2)(iii) references a 1994 edition of the 2003 IEEE standard that OSHA referenced in the note to proposed paragraph (b). He also noted that the "wet" test procedure in an ASTM standard differs from the one in the IEEE standard. Mr. Muckerheide explained:

> [Paragraph (j)(2)(iii)(D) of existing § 1910.269 and proposed § 1926.957(b)(3)(iv)] require the integrity testing of fiberglass-reinforced plastic tools under "wet conditions" but it does not define "wet conditions". The note for paragraph 1926.957(b)(3)(iv) refers to IEEE Std 516–2003 while the note for 1910.269(j)(2)(iii)(D) refers to IEEE Std 978–1984. IEEE Std 978–1984 is no longer supported by IEEE. There is also an ASTM standard, F711–02, that establishes specifications for live-line tools. Both have a test protocol for "wet conditions". However, they are not identical. One specifies a 7 day 93% humidity test and the other a fine mist of distilled water. [Ex. 0180]

He recommended that both § 1910.269 and subpart V require testing under wet conditions to conform to the "current version of IEEE Std 516."

OSHA notes that the test procedure and criteria in ASTM F711 are design or acceptance tests for new live-line tools, while the tests in the IEEE standard are in-service tests. As noted earlier, design and acceptance tests generally are more severe than in-service tests and can damage tools if repeated on a regular basis. A tool in new condition should perform at an optimal level. Once a tool has been in service for a while, it will typically exhibit reduced performance because the tool deteriorates as it is handled—it develops microscopic scratches and becomes contaminated with creosote and other substances. To account for this deterioration, in-service testing frequently uses different test procedures or test criteria, or both. In the final standard, the Agency provides employers flexibility in adopting test procedures and criteria. Thus, test procedures and criteria are acceptable as long as they meet the performance requirements of the standard, that is, they "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." As explained in detail under the summary and explanation for final § 1926.97, earlier in this section of the preamble, OSHA is adopting performance requirements rather than incorporating consensus standards by reference for a number of reasons, including allowing greater compliance flexibility and reducing the need to update the OSHA standards as frequently.

As explained in the summary and explanation for Appendix G, later in this section of the preamble, OSHA is updating the consensus standards specified in nonmandatory references throughout final § 1910.269 and final subpart V. In this case, the note to final § 1910.269(j)(2) includes an updated reference to IEEE Std 516–2009 to match the corresponding note to final § 1926.957(b). (See the summary and explanation of § 1926.97, earlier in this preamble, for a discussion of OSHA's approach regarding future updates of the consensus standards referenced in this final rule.)

Section 1926.958, Materials Handling and Storage

Final § 1926.958 is equivalent to existing § 1910.269(k) and contains requirements for materials handling and storage. Final paragraph (a) clarifies that material-handling and material-storage requirements in Part 1926, including those in Subparts N and CC, apply. Proposed paragraph (a) referenced only Subpart N.[163] However, OSHA recently

high-humidity (at least 93-percent humidity) chamber for 168 hours. After conditioning and before testing, the tool is wiped with a dry cloth. Thus, the outside of the tool is dry during both tests.

[162] When an employer removes a tool from service under final paragraph (b)(2) and inspects and tests it under final paragraph (b)(3), the 2-year cycle begins again on the date of the test.

[163] When subpart V was originally promulgated in 1972, that final rule also added a standard for aerial

Continued

revised its cranes and derricks standard, former § 1926.550, which was in subpart N when OSHA published the proposed rule for subpart V. The recently published cranes and derricks final rule moved the requirements for cranes and derricks into a new subpart, subpart CC of part 1926 (75 FR 47906, Aug. 9, 2010).[164] Consequently, the Agency is including a reference to this new subpart in final § 1926.958(a). Work performed under subpart V is exempt from certain requirements in subpart CC. For example, § 1926.1408(b)(5) exempts cranes and derricks used in subpart V work from § 1926.1408(b)(4), which requires employers to adopt one of several encroachment-prevention measures for certain work near overhead power lines. Any exemptions in subpart CC for subpart V work continue to apply; those exemptions are not affected by this final rule.

It should be noted that Subparts H and O of OSHA's construction standards also contain requirements pertaining to material handling and storage. For example, § 1926.602 covers material-handling equipment. These provisions continue to apply even though they are not specifically mentioned in final § 1926.958(a). (See final § 1926.950(a)(2).) To make this clear in the final rule, OSHA reworded § 1926.958(a) in the final rule to require material handling and storage to "comply with applicable material-handling and material-storage requirements in this part, including those in subparts N and CC of this part."

Paragraph (b) addresses the storage of materials in the vicinity of energized lines and equipment. Paragraph (b)(1), which is being adopted without substantive change from the proposal, contains requirements for areas to which access is not restricted to qualified employees only. As a general rule, the standard does not permit materials or equipment to be stored in such areas within 3.05 meters (10 feet) of energized lines or exposed parts of equipment. This clearance distance must be increased by 0.10 meters (4 inches) for every 10 kilovolts over 50 kilovolts. The distance also must be increased to account for the maximum sag and side swing of any conductor and to account for the height and movement of material-handling equipment. Maintaining these clearances protects unqualified employees from contacting energized lines or equipment with materials being handled. Storing materials at the required distances also will facilitate compliance with provisions elsewhere in the construction standards that require material-handling equipment to maintain specific distances from energized lines and equipment, such as § 1926.600(a)(6).[165]

The work practices unqualified workers must use in handling material stored near energized lines, including in areas addressed by final § 1926.958(b)(1), are addressed elsewhere in Part 1926, including subparts K and CC of part 1926. The general approach taken in this revision of subpart V is to provide safety-related work practices for qualified employees to follow when they are performing electric power transmission and distribution work, including work in areas addressed by final § 1926.958(b)(1). (See the summary and explanation for final § 1926.950(a)(1)(ii).)

Mr. Kenneth Brubaker was concerned that unqualified employees storing materials near energized lines or equipment could not determine the relevant voltage and recommended specifying clearance distances that did not require calculations based on voltage (Exs. 0099, 0100).

OSHA is not adopting Mr. Brubaker's recommendation. As noted under the summary and explanation for final § 1926.950(a)(1)(ii), subpart V does not apply to electrical safety-related work practices for unqualified employees. Paragraph (b)(1) of final § 1926.958 specifies minimum clearance distances between energized lines or exposed energized parts and stored material or equipment. The electrical safety-related work practices used by unqualified employees handling the stored material or equipment are addressed in subparts of part 1926 other than subpart V. In any event, the employer is responsible for determining where to store material and equipment so as to comply with final § 1926.958(b)(1), which addresses Mr. Brubaker's concern that unqualified employees will be determining these distances.

Paragraph (b)(2), which is being adopted without substantive change from the proposal, governs the storage of materials in areas restricted to qualified employees. If the materials are stored where only qualified workers have access to them, the materials may be safely stored closer to the energized parts than 3.05 meters (10 feet), provided that the employees have sufficient room to perform their work. Therefore, to ensure that enough room is available, paragraph (b)(2) prohibits material from being stored in the working space around energized lines or equipment. A note to this paragraph clarifies that requirements for the size of the working space are contained in § 1926.966(b). (See the discussion of final § 1926.966(b) later in this preamble for an explanation of requirements for access and working space.)

Working space under this provision is the clear space that must be provided around the equipment to enable qualified employees to work on the equipment. The minimum working space specifies the minimum distance an obstruction can be from the equipment. For example, if a switchboard is installed in a cabinet that an employee will enter, the inside walls of the cabinet must provide sufficient minimum working space to enable the employee to work safely within the cabinet.

The minimum approach distance that must be maintained from a live part is the minimum dimension of the space around the equipment that a qualified employee is not permitted to enter, except under specified conditions. Note that the minimum approach distance a qualified employee must maintain from an energized part (covered in final § 1926.960(c)(1)) is smaller than the working space that is required to be provided around the part. Accordingly, the employee must enter the working space and still maintain the minimum approach distance unless one of the exceptions specified in § 1926.960(c)(1) applies. Employers must ensure that materials are stored outside the working space so that employees can quickly

lifts to subpart N. That aerial lift standard, which originally appeared at § 1926.556, eventually was redesignated as § 1926.453, in subpart L. It should be noted that, except for § 1926.453(b)(2)(v), the aerial lift standard still applies to work covered by subpart V even though it is not referenced in final § 1926.958 or final § 1926.959. (See § 1926.950(a)(2).) See, also, the summary and explanation for final § 1926.954(b)(3)(iii) for a discussion of why the fall protection requirement in § 1926.453(b)(2)(v) does not apply to work covered by Subpart V.

[164] Subpart CC applies to power-operated equipment, when used in construction, that can hoist, lower, and horizontally move a suspended load. The discussion of Subpart CC in the preamble to the Subpart V final rule refers to this equipment as "cranes and derricks."

[165] OSHA's revised standard for cranes and derricks at subpart CC requires minimum clearance distances for cranes and derricks, which, under certain conditions, are greater than the distances specified by final § 1926.958(b)(1). Therefore, employers covered by subpart V must be knowledgeable about these requirements when they store materials that are lifted by equipment covered under subpart CC and may need to adjust the clearance distances for storing materials away from energized lines and equipment accordingly. (For work covered by subpart V, compliance with final § 1926.959 is deemed compliance with the relevant requirements in subpart CC (per § 1926.1400(g)). However, employers must comply with subpart CC clearance distances for work performed by unqualified employees because subpart V does not contain electrical safety-related work practices for those workers. See final § 1926.950(a)(1)(ii).)

escape from the space if necessary. In addition, sufficient room must be available in the working space to allow employees to move without violating the minimum approach distance.

Section 1926.959, Mechanical Equipment

Requirements for mechanical equipment are contained in § 1926.959. Paragraph (a) sets general requirements for mechanical equipment used in the construction of electric power transmission or distribution lines and equipment. Paragraph (a)(1) provides that mechanical equipment must be operated in accordance with applicable requirements in part 1926, including subparts N, O, and CC, except for one requirement pertaining to the operation of mechanical equipment near energized power lines at § 1926.600(a)(6), which does not apply to operations performed by qualified employees. Accordingly, § 1926.600(a)(6) continues to apply to operations performed by unqualified employees. Final subpart V contains requirements for the operation of mechanical equipment by qualified employees near energized power lines and equipment. While the final rule allows qualified employees to operate equipment closer to energized lines and equipment than permitted for unqualified employees by § 1926.600(a)(6), the final rule also contains the relevant safeguards for protecting these employees. These safeguards include special training for qualified employees (see § 1926.950(b)(2)) and the use of special safety procedures for operations involving mechanical equipment (see § 1926.959(d)). Therefore, OSHA believes that the final rule will provide more appropriate protection for qualified electric power transmission and distribution workers than § 1926.600(a)(6). OSHA revised the language of final § 1926.959(a)(1) from the proposal to clarify this point and to be more consistent with final § 1926.958(a).

OSHA proposed to exempt subpart V operations performed by qualified employees from § 1926.550(a)(15) in subpart N, which specified minimum approach distances for cranes and derricks. As noted earlier, however, after OSHA published proposed subpart V, the Agency revised its standard for cranes and derricks. The revised requirements for cranes and derricks were relocated to subpart CC. In the cranes and derricks rulemaking, OSHA concluded that the provisions for operating cranes and derricks near overhead power lines in subpart CC were reasonable and appropriate and were more protective of employees than comparable provisions in existing subpart V. However, the Agency also concluded that existing § 1910.269(p) was just as protective of employees as the requirements for operating cranes and derricks near power lines adopted in subpart CC. (See 75 FR 47921, 47930, 47965–47966.) Accordingly, OSHA deemed compliance with existing § 1910.269(p) as compliance with §§ 1926.1407 through 1926.1411. (See § 1926.1400(g).) The exemptions for subpart V work specified in subpart CC (or elsewhere in part 1926) continue to apply; however, as explained later in this section of the preamble, the Agency revised several provisions in subpart CC to incorporate changes to subpart V in this final rule.

Paragraph (a)(2) of final § 1926.959 requires that the critical safety components of mechanical elevating and rotating equipment receive a thorough visual inspection before use on each shift. Although the inspection must be thorough, it is not necessary to disassemble the equipment. The note following this paragraph describes what equipment parts OSHA considers to be critical safety components, that is, any part for which failure would result in a free fall or free rotation of the boom. These parts are critical to safety because failure would immediately pose serious hazards to employees, as can be seen in several aerial-lift accidents in the record (Ex. 0004 [166]). This provision is adopted as proposed.

Paragraph (a)(3), which is being adopted without substantive change from the proposal, prohibits the operator of an electric line truck from leaving his or her position at the controls while a load is suspended, unless the employer can demonstrate that no employee, including the operator, would be endangered if the operator left his or her position. This provision ensures that the operator will be at the controls if an emergency arises that necessitates moving the suspended load. For example, due to wind or unstable soil, the equipment might start to tip over. Having the operator at the controls ensures that corrective action can be taken quickly enough to prevent an accident.

Paragraph (b) sets requirements for outriggers. As proposed, paragraph (b)(1) would have required that mobile equipment [167] provided with outriggers be operated with the outriggers extended and firmly set "as necessary for the stability of the specific configuration of the equipment." The manufacturer normally provides limits for various configurations to ensure the stability of the equipment, but these limits can also be derived through engineering analysis.

Mr. Frank Owen Brockman with Farmers Rural Electric Cooperative Corporation commented that outriggers "should be used any time the boom is out of the cradle" (Ex. 0173).

In considering this comment, OSHA examined accidents in the record involving overturned mobile equipment. There were several such accidents in the record involving equipment that overturned, and at least two of them occurred because the outriggers were not set (Exs. 0002, 0400 [168]). Based on these accidents, OSHA believes that, even if employees setting up mobile mechanical equipment expect to operate the equipment within its stability limits, they may inadvertently go beyond those limits while operating the equipment. Consequently, the Agency agrees with Mr. Brockman that outriggers should always be set, at least when it is possible to do so. Therefore, in paragraph (b)(1) of the final rule, OSHA is requiring the outriggers of mobile

[166] See, for example, the seven accidents described at *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=9511458id=200200137&id=928168&id=908343&id=837740&id=142448188id=564765.*

[167] Paragraphs (p)(1)(ii) and (p)(2) of existing § 1910.269 use the term "vehicular equipment," which is not defined in existing § 1910.269(x). Existing paragraph (p)(1)(ii) requires reverse-signal alarms under certain conditions. This paragraph "is based on existing §§ 1926.601(b)(4) and 1926.602(a)(9)(ii)" (59 FR 4399). Existing § 1926.601(b)(4) contains a reverse-signal-alarm requirement applicable to motor vehicles, and existing § 1926.602(a)(9)(ii) contains a similar requirement applicable to earthmoving and compacting equipment. Because those construction standards apply to motor vehicles and earthmoving and compacting equipment, the term "vehicular equipment" in existing § 1910.269(p)(1)(ii), which OSHA drew from those construction standards, means motor vehicles and earthmoving and compacting equipment.

Existing § 1910.269(p)(2) generally requires vehicular equipment, if provided with outriggers, to be operated with the outriggers extended and firmly set. Thus, "vehicular equipment" in existing § 1910.269(p)(2) applies more broadly to mobile equipment fitted with outriggers.

In the final rule, OSHA is clarifying these two provisions in § 1910.269 and the provision in § 1926.959(b), which corresponds to existing § 1910.269(p)(2). First, OSHA is replacing the term "vehicular equipment" in the introductory text to paragraph (p)(1)(ii) with "motor vehicle or earthmoving or compacting equipment" to make it clear that § 1910.269(p)(1)(ii) applies to the same equipment as §§ 1926.601(b)(4) and 1926.602(a)(9)(ii). Second, the Agency is using the term "mobile equipment" in final §§ 1910.269(p)(2)(i) and 1926.959(b)(1) in place of the term "vehicular equipment." "Mobile equipment," as used in these paragraphs, means mechanical equipment that is mounted on a body, such as a truck, that is used to transport the equipment.

[168] See the two accidents described at *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=170872162&id=201403771.*

equipment to be extended and firmly set, except as permitted in paragraph (b)(3), which provides for the safe operation of the equipment when the work area or terrain precludes the use of outriggers.

The second sentence of proposed paragraph (b)(1) would have prohibited outriggers from being extended or retracted outside the clear view of the operator unless all employees were outside the range of possible equipment motion. There were no comments on this provision, and OSHA is including this requirement as paragraph (b)(2) in the final rule. This requirement will prevent injuries caused by extending outriggers into employees.

If the work area or terrain precludes the use of outriggers, proposed paragraph (b)(2) would have permitted the operation of the equipment only within the maximum load ratings specified by the manufacturer for the particular equipment configuration without outriggers. There were no comments on this provision, and OSHA is including this requirement in paragraph (b)(3) in the final rule. The requirements contained in paragraphs (b)(1) and (b)(3) will ensure the stability of the equipment while loads are being handled, thereby preventing equipment tipovers, which could harm employees.

Paragraph (c), which is being adopted without substantive change from the proposal, requires mechanical equipment used to lift or move lines or other material to be operated within its maximum load rating and other design limitations for the conditions under which it is being used. As OSHA explained in the preamble to the proposal, it is important for mechanical equipment to be used within its design limitations so that the lifting equipment does not fail during use and harm employees (70 FR 34858).

In electric-utility operations, contact between live parts and mechanical equipment causes many fatalities each year. A sample of typical accidents involving the operation of mechanical equipment near overhead lines is given in Table 4. Industry practice (Exs. 0041, 0076, 0077), and existing rules in Subpart V (§§ 1926.952(c) and 1926.955(a)(5)(ii)), require that mechanical equipment be kept from exposed energized lines and equipment at distances generally greater than or equal to those proposed in Table V–2 (AC Live-Line Work Minimum Approach Distance). However, incidents involving contact between mechanical equipment and energized parts still occur during the hundreds of thousands of operations performed near overhead power lines each year (Ex. 0017). If the equipment operator is distracted briefly or if the distances involved or the speed of the equipment towards the line is misjudged, contact with the lines is likely to occur, especially when the minimum approach distances are small. Because these types of contacts cannot be totally avoided, OSHA believes that additional requirements, beyond provisions for maintaining minimum approach distances, are necessary for operating mechanical equipment near exposed energized lines. Paragraph (d) of final § 1926.959 addresses this issue.

TABLE 4—ACCIDENTS INVOLVING THE OPERATION OF MECHANICAL EQUIPMENT NEAR OVERHEAD LINES

Type of equipment	Number of fatalities				Types of accident
	Total	Grounded			
		Yes	No	?	
Boom Truck/Derrick Truck	9	2	.....	7	Boom contact with energized line. Pole contact with energized line.
Aerial Lift	8	.....	1	7	Boom contact with energized line.
	.....	.....	.....	.....	Lower boom contact with energized line.
	.....	.....	.....	.....	Employee working on deenergized line when upper boom contacted energized line.
	.....	.....	.....	.....	Electric current arced from a winch on a lift used on an energized line to nearby ground.
Vehicle	2	.....	1	1	Line fell on vehicle.
	.....	.....	.....	.....	Unknown type of vehicle and type of accident.
Total	19	2	2	15	

Source: OSHA accident investigation data (269-Exs. 9–2 and 9–2A).

Mr. Brian Erga with ESCI proposed a complete revision of proposed paragraph (d) (Exs. 0155, 0471; Tr. 1249–1253). OSHA decided not to adopt this proposal. The Agency addresses his specific concerns and recommendations in the following discussion of the individual provisions of proposed paragraph (d).

Proposed paragraph (d)(1) would have required that the minimum approach distances in Table V–2 through Table V–6 be maintained between the mechanical equipment and live parts while the equipment was being operated near exposed energized lines or equipment. This provision would ensure that sufficient clearance is provided between the mechanical equipment and the energized part to prevent an electric arc from occurring and energizing the equipment. The requirement to maintain a minimum approach distance also lessens the chance that the mechanical equipment will strike the lines and knock them to the ground. (See 70 FR 34858–34859; 59 FR 4400–4401.)

Mr. Brian Erga with ESCI objected to the prohibition against taking mechanical equipment inside the minimum approach distance (MAD), commenting:

> [The proposal] requires that mechanical equipment can not be allowed within the minimum approach distance. However, the electric utility industry routinely works near MAD, at MAD, and takes mechanical equipment into MAD during many industry accepted work practices many times per day. [Ex. 0155]

Mr. Erga argued that proper work methods and grounding would prevent accidents involving mechanical equipment contacting overhead power lines. He expanded on his comments in his posthearing submission:

> During cross examination at the public hearing on March 2006, speakers from EEI, NECA, IBEW and others, testified that qualified workers routinely take mechanical equipment into the Minimum Approach Distance (MAD). In cross examination of Mr. Tomaseski, IBEW Director of Safety, was asked, "is mechanical equipment taken inside the minimum approach distance at times?" Mr. Tomaseski replied "regularly,"

and he further stated "it could be (the standard) rewritten to offer a better level of safety."

This standard industry practice of taking mechanical equipment into MAD occurs when qualified workers are setting new poles, installing transformers, installing equipment and moving conductors with mechanical equipment. This practice is safe and effective if [proper work methods are used].

Table IV–5 "Accidents Involving the Operation of Mechanical Equipment Near Overhead Lines," page 34859 of the **Federal Register**, dated June 15, 2005, details fatalities around mechanical equipment that were grounded, ungrounded, or not known. However, the table does not detail how the equipment was grounded, if proper cover-up was used or if any safety precaution was taken. To date there has never been a documented case of a worker being injured or killed around properly grounded mechanical equipment, or when the proper work methods . . . have been used.

And, as clearly seen in the IEEE paper 91 SM 312–9 PWRD "Tests Results of Grounding Uninsulated Aerial Lift Vehicles Near Energized Lines" (Attachment 1), whether the vehicle was left ungrounded or grounded to a temporarily driven ground rod, neither of these two practices provided any worker protection. However, when the vehicle was grounded to a proper ground source, electrical hazards to workers were greatly reduced to survival levels. Use of insulated cover-up on the exposed energized lines and equipment, or the use of insulated and tested mechanical equipment are industry accepted and safe work procedures which should be supported by OSHA. [Ex. 0471]

OSHA does not dispute Mr. Erga's evidence regarding the effectiveness of grounding and addresses that issue in the discussion of paragraph (d)(3)(iii), later in this section of the preamble. Although Mr. Erga maintains that "qualified workers routinely take mechanical equipment into the Minimum Approach Distance" (Ex. 0471), OSHA does not consider this a valid reason for eliminating proposed paragraph (d)(1) from § 1926.959. Mr. Erga did not demonstrate that it is infeasible to comply with proposed paragraph (d)(1). In fact, when performing tasks such as installing poles or equipment, employers can use temporary arms or other live-line tools to move the lines far enough away from mechanical equipment so that the equipment maintains the required minimum approach distance (269-Ex. 8–5). Moreover, insulated aerial lifts (discussed later in this section of the preamble) can be used to install equipment and move conductors (*id.*)

Mr. Erga also maintains that grounding mechanical equipment and other safety precautions, such as insulating the lines with coverup, provide better protection than the proposed rule. However, he did not explain how grounding, insulated coverup, or any of the other practices he recommended protect employees from conductors being knocked down as a result of contact by mechanical equipment. The practices he recommended can help protect employees who contact energized equipment; however, those practices do not protect employees from being injured or killed by energized lines contacting them directly or energizing the earth around them.

Proposed § 1926.959(d)(1) was equivalent to existing § 1910.269(p)(4)(i). Mr. Erga was the only rulemaking participant in either this rulemaking or the 1994 rulemaking to object to the prohibition against taking mechanical equipment into the minimum approach distance. OSHA concludes that this provision of proposed paragraph (d)(1) is reasonably necessary and appropriate and is including it in the final rule.

The proposal specified minimum approach distances in proposed Table V–2 through Table V–6. However, in the final rule, § 1926.960(c)(1)(i) requires the employer to establish minimum approach distances. (See the summary and explanation of § 1926.960(c)(1)(i), later in this section of the preamble.) Accordingly, final § 1926.959(d)(1) requires mechanical equipment to maintain "the minimum approach distances, established by the employer under § 1926.960(c)(1)(i)" rather than "the minimum approach distances of Table V–2 through Table V–6," as proposed.

Mr. Erga questioned whether proposed paragraph (d)(1) allowed a qualified employee to "use insulating protective material to cover the line and then go into [the minimum approach distance] with a conductive boom" (Ex. 0155). The word "exposed" is defined in final § 1926.968 as "[n]ot isolated or guarded." The word "isolated" is defined in final § 1926.968 as "Not readily accessible to persons unless special means for access are used." (See the summary and explanation for final § 1926.960(b)(3) for a discussion of this definition.) The word "guarded" is defined in final § 1926.968 as 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. A note following the definition of "guarded" explains that conductors that are insulated, but not otherwise protected, are not guarded. Thus, energized lines and equipment that are protected only by rubber insulating equipment are neither guarded nor isolated from the mechanical equipment and would, consequently, still be "exposed" for purposes of final paragraph (d)(1). Therefore, under these conditions, employers must ensure that mechanical equipment complies with the minimum approach distance.

Proposed paragraph (d)(1) provided an exception permitting the insulated portion of an aerial lift operated by a qualified employee located in the lift to breach the minimum approach distance. The Agency is adopting this exception in final paragraph (d)(1) with only minor editorial changes. As OSHA noted in the preamble to the proposal, aerial lifts are designed to enable an employee to position himself or herself at elevated locations with a high degree of accuracy (70 FR 34859). The aerial-lift operator is in the bucket next to the energized lines and, therefore, can easily judge the approach distance. This requirement minimizes the chance that the equipment will contact an energized line and that the energized line will be struck down should such contact occur. Furthermore, the employee operating the lift in the bucket would be protected under the provisions of final § 1926.960 from the hazards of contacting the live parts. As the aerial lift is insulated, employees on the ground are protected from electric shock in case the aerial lift contacts the lines, provided that the contact is made above the insulated section of the boom. OSHA further noted in the preamble to the proposal that § 1926.959(c) [169] and other provisions would protect employees against the possibility that the aerial lift would strike down the power line (*id.*).

Two commenters requested clarification of the exception specified in proposed paragraph (d)(1) for parts of insulated aerial lifts (Exs. 0186, 0192). Mr. Anthony Ahern of Ohio Rural Electric Cooperatives requested clarification regarding the portion of the boom of an aerial-lift truck that would be considered uninsulated (Ex. 0186). He noted that some aerial devices have second insulated inserts in the lower portion of their booms and that some companies treat these inserts as secondary protection and do not regularly dielectrically test them (*id.*). In

[169] Paragraph (c) of final § 1926.959 requires mechanical equipment used to lift or move lines to be used within its maximum load rating and other design limitations. This provision will ensure that an aerial lift used to move an overhead line conductor is designed for that purpose and operated in a manner that will not cause the conductor to fail.

addition, an aerial-lift manufacturer, Altec Industries, offered these comments:

> It is important to clarify that insulated aerial lifts have conductive components located above their insulated sections. The insulated aerial lift allows a qualified employee using appropriate PPE to approach within the minimum approach distance to a single unguarded energized conductor. However the minimum approach distance to other unguarded conductors at different potentials remain in effect. The qualified employee may not approach, or take any conductive object, including conductive portions of an insulated aerial lift (e.g., material handling system) that are located above its insulated section, into the minimum approach distance of two unguarded conductors at different electrical potential. [Ex. 0192]

Altec recommended that the exception be worded, in part: "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 ARE maintained between the CONDUCTIVE PORTIONS OF THE AERIAL LIFT LOCATED ABOVE INSULATION, THE uninsulated portions of the aerial lift and exposed objects at a different potential" (*id.;* emphasis in original).

Final paragraph (d)(1) will protect employees on the ground by ensuring that the equipment does not become energized and that the overhead power lines are not knocked to the ground. Both of these conditions pose hazards for ground workers. For the purposes of final paragraph (d)(1), OSHA considers "the insulated portion of an aerial lift" to be that portion of an insulated aerial lift that is on the end of the insulated boom section farthest from the vehicle supporting the aerial lift. This is the portion of the aerial device that is insulated from the vehicle. If contact with an energized line is made on this portion of the boom, employees on the ground are protected.[170] The Agency does not believe that Altec's recommended language would further clarify this requirement. In addition, OSHA does not consider insulated inserts that the employer does not deem to be insulation, or does not maintain, to be part of the insulated portion of the aerial lift as specified by final paragraph (d)(1).

It should be noted that, even if the exception in final paragraph (d)(1) for the insulated portions of aerial lifts applies, the employee must still maintain the minimum approach distances to the extent required in final § 1926.960(c)(1). In addition, final § 1926.959(d)(1) requires the conductive portions of the boom to continuously maintain the minimum approach distances from conductive objects at potentials different from that on which the employee is working. It should also be noted that the insulating portion of the boom can be bridged by improper positioning of the boom or by conductive objects suspended from the aerial lift platform. For example, the insulating portion of the boom will be bridged when it is resting against a grounded object, such as a utility pole, or when the employee in an aerial bucket is holding onto a grounding jumper. For purposes of final § 1926.959(d)(1), OSHA does not consider any part of the aerial lift to be insulated when the insulation is bridged.

Paragraph (d)(2), which is being adopted without substantive change from the proposal, requires a designated employee to observe the operation and give timely warnings to the equipment operator before the minimum approach distance is reached. There is an exception to this requirement for situations in which the employer can demonstrate that the operator can accurately determine that the minimum approach distance is being maintained. As OSHA explained in the preamble to the proposal, determining the distance between objects that are relatively far away from an equipment operator who is standing on the ground can sometimes be difficult (70 FR 34859). For example, different visual perspectives can lead to different estimates of the distance, and lack of a suitable reference point can result in errors (269-Ex. 8–19). In addition, an operator may not be in the best position to observe the clearance between an energized part and the mechanical equipment because, for example, an obstruction may block his or her view.

An aerial-lift operator would not normally need to judge the distance between far away objects. In most cases, an aerial-lift operator is maintaining the minimum approach distance from energized parts relatively close to himself or herself, and it should be easy for him or her to stay far enough away from these parts. In such cases, the employer would normally be able to demonstrate that the employee can maintain the minimum approach distance without an observer. However, even an aerial-lift operator may have difficulty maintaining the minimum approach distances in certain circumstances. For example, the congested configuration of some overhead power lines may necessitate maintaining clearance from more than one conductor at a time, or an aerial-lift operator may need to judge the distance between the lower, uninsulated portion of the boom and a conductor that is located well below the operator. In these situations, in which it is unlikely that an employer could demonstrate that the operator could accurately determine that the required distance is being maintained, an observer is required.

Final paragraph (d)(3) will protect employees, primarily employees on the ground, from electric shock in case contact is made between the mechanical equipment and the energized lines or equipment. This paragraph requires employers to take one of three alternative protective measures if the equipment can become energized. The first option (paragraph (d)(3)(i)) requires that energized lines or equipment exposed to contact with the mechanical equipment be covered with insulating protective material that will withstand the type of contact that could be made during the operation. The second option (paragraph (d)(3)(ii)) requires the mechanical equipment to be insulated for the voltage involved. Under this option, the mechanical equipment must be positioned so that uninsulated portions of the equipment cannot come within the applicable minimum approach distance of the energized line or equipment.[171]

Mr. Brian Erga with ESCI was concerned about the requirement in proposed paragraph (d)(3)(ii) that insulated equipment be positioned so that its uninsulated portions cannot approach energized lines or equipment closer than the minimum approach distance, commenting:

> OSHA 1910.269(p)(4) is currently being read word for word that when using the insulated portion of mechanical equipment, the un-insulated portion cannot possibly ever reach into [the minimum approach distance]. This requires the truck to be positioned so far away that it cannot lift anything, and is often impractical since the truck may need to be 30 feet from the pole or line to keep the possibility of the un-insulated portion entering [the minimum approach distance]. [Ex. 0155]

Paragraph (d)(3)(ii) in the final rule, which applies to insulated equipment, requires the mechanical equipment to be positioned so that the uninsulated

[170] Requiring the equipment to be operated by an employee in the aerial lift, who has better control over the distance between the equipment and the power line than an operator on the ground, also ensures that the line is not knocked down.

[171] This provision contrasts with final paragraph (d)(1), which prohibits mechanical equipment (except, in some situations, the insulated portion of an aerial lift) from being taken closer than the minimum approach distance to exposed energized lines and equipment, but allows the equipment to be positioned so that it is possible to breach that distance.

portion cannot approach any closer than the minimum approach distance. OSHA understands that this may not always be practical, depending on the work to be performed, the location of the energized lines and equipment, and available operating positions for the mechanical equipment. However, the Agency notes that this paragraph presents one of three options that employers may take to comply with final paragraph (d)(3). The first and third options, in final paragraphs (d)(3)(i) and (d)(3)(iii), permit mechanical equipment, including insulated equipment, to be positioned more closely to energized lines and equipment provided that employers take the precautions specified in those paragraphs. (Note that final paragraph (d)(1) still generally requires mechanical equipment to be *operated* so that the minimum approach distances, established by the employer under final § 1926.960(c)(1)(i), are maintained from exposed energized lines and equipment, regardless of where the equipment is *positioned*.)

The third compliance option, specified in final paragraph (d)(3)(iii), is for each employee to be protected from the hazards that could arise from contact of mechanical equipment with the energized lines or equipment. The measures used must ensure that employees will not be exposed to hazardous differences in electric potential. Based on the § 1910.269 rulemaking record, OSHA concluded that vehicle grounding alone could not always provide sufficient protection against the hazards of mechanical equipment contact with energized power lines (59 FR 4403). However, the Agency recognized the usefulness of grounding as a protective measure against electric shock when it is used with other techniques. Therefore, proposed paragraph (d)(3)(iii), which was equivalent to existing § 1910.269(p)(4)(iii)(C), required:

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

(2) Bonding equipment together to minimize potential differences,

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

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

To comply with the third compliance option in final paragraph (d)(3)(iii), the employer must use all of these techniques, unless it can show that it is using other methods that protect each employee from the hazards that could arise if the mechanical equipment contacts the energized lines or equipment. The techniques listed in paragraph (d)(3)(iii): (1) minimize differences in electrical potential, (2) minimize the time employees would be exposed to hazardous electrical potentials, and (3) protect against any remaining hazardous electrical potentials. The performance-oriented requirements in final paragraph (d)(3)(iii) assure that employees are protected from the hazards that could arise if the mechanical equipment contacts energized parts. Information in Appendix C to final subpart V provides guidelines for employers and employees that explain various measures for protecting employees from hazardous differences in electrical potential and how to use those measures. A note referencing this appendix is included after final paragraph (d)(3)(iii).

Mr. Erga objected to proposed paragraph (d)(3)(iii). He recommended that mechanical equipment always be grounded "cradle to cradle," that is, from the time the boom lifts out of the cradle until it returns (Tr. 1237) and that it always be grounded when it comes within 3 meters (10 feet) of energized lines or equipment (Tr. 1252). He recommended further that the standard provide three options to supplement this grounding requirement: (1) that the lines or equipment be covered, (2) that the mechanical equipment be insulated, or (3) that barricades, ground mats, and rubber insulating gloves be used (Tr. 1252).

OSHA concludes that it is not always necessary to ground mechanical equipment operated near energized lines or equipment. Under the first option in final paragraph (d)(3), the energized lines or equipment are covered with insulating protective material that will withstand the type of contact that could be made during the operation. This option should prevent the mechanical equipment from becoming energized, and the Agency, therefore, concludes that grounding is unnecessary for this option. Under the second option in final paragraph (d)(3), the uninsulated portion of insulated mechanical equipment must be positioned so that it cannot approach any closer than the minimum approach distance. This option also should prevent the mechanical equipment from becoming energized, and the Agency concludes that grounding is unnecessary under this option as well.

The third option in final paragraph (d)(3) requires that mechanical equipment be grounded unless the employer can demonstrate that other methods in use will protect each employee from the hazards that could arise if the mechanical equipment contacts the energized lines or equipment. In his comments, Mr. Erga referred to an IEEE paper on grounding, explaining:

> IEEE paper 91 SM 312–9 PWRD "Test results of grounding un-insulated aerial lift vehicles near energized distribution lines" . . . clearly shows mechanical equipment grounded to the best available ground reduces the voltage and current exposed to the worker by more than 96%. The ESCI staff knows of no electrical worker *ever killed or injured* around properly grounded mechanical equipment that has become accidentally energized. [Ex. 0155; emphasis included in original]

The IEEE paper to which Mr. Erga referred clearly shows that using the best available ground provides the most protection for employees and, therefore, supports the requirement in final paragraph (d)(3)(iii)(A) to ground the mechanical equipment to the best available ground (Ex. 0472). However, the paper also demonstrates that this ground is insufficient by itself to protect employees fully. With grounding alone, the current through a resistor of more than 900 ohms is high enough to injure and possibly kill an employee. OSHA has considered the minimum resistance of an employee to be 500 ohms, not 1,000 ohms, as specified in the paper (59 FR 4406). As NIOSH states in its Publication No. 98–131, *Worker Deaths by Electrocution: A Summary of NIOSH Surveillance and Investigative Findings*, "High-voltage electrical energy quickly breaks down human skin, reducing the human body's resistance to 500 Ohms" (Ex. 0141). Using Ohm's Law, current is inversely proportional to resistance, and the current through a 500-ohm resistor would be nearly twice the current shown in the IEEE paper. In addition, the testing for the IEEE paper was performed with a 7,200-volt power line. Distribution and transmission lines of higher voltages, which are not uncommon, would result in even higher currents through a resistor. Thus, the evidence provided by Mr. Erga demonstrates the need for additional measures beyond grounding, such as the measures required by the final rule.

As noted earlier, final paragraph (d)(3)(iii) requires the employer to take specified measures unless it can demonstrate that the methods in use protect each employee from the hazards that could arise if the equipment contacts the energized line or equipment. Mr. Erga's proposal would require only two of those measures: Grounding and one of three additional measures, two of which are comparable to measures required by final paragraph (d)(3)(iii). OSHA continues to believe that all of the measures listed in final

paragraph (d)(3)(iii) will protect employees from hazardous differences in electrical potential as explained in the preamble to the 1994 § 1910.269 final rule (59 FR 4402–4403). Employers are free to use other protective measures, including those proposed by Mr. Erga, but these employers must demonstrate that the methods in use protect each employee from the hazards that could arise if the equipment contacts an energized line or equipment. OSHA concludes that it is important for employers that do not implement all of the measures required by final paragraph (d)(3)(iii) to evaluate their systems, and the alternative measures they select, to ensure that employees are protected. Therefore, OSHA is not adopting Mr. Erga's recommended changes to paragraph (d)(3)(iii).

OSHA is including paragraph (d)(3) in the final rule substantially as proposed. The Agency has, however, made technical changes to the proposed language to clearly distinguish between references to mechanical equipment and references to energized equipment. Several provisions in proposed paragraph (d)(3) used the word "equipment" without specifying whether it meant the mechanical equipment itself or the energized equipment that the mechanical equipment could contact. Although the language was clear from the context, the final rule consistently states which term applies. Also, in two places, proposed paragraph (d)(3) used the term "energized lines" when OSHA meant "energized lines or equipment." The final rule corrects these oversights. In addition, final paragraph (d)(3)(ii) requires mechanical equipment to maintain "the minimum approach distances, established by the employer under § 1926.960(c)(1)(i)," rather than "the minimum approach distances specified in Table V–2 through Table V–6," as proposed.

11. Section 1926.960, Working on or Near Exposed Energized Parts

Paragraph (a) specifies the scope of § 1926.960 of the final rule. This section applies to work on exposed live parts and work near enough to such parts to expose the employee to any hazard they present. Many of the provisions in this section have been taken directly from existing § 1910.269(l).

Paragraph (b) contains general requirements for working on or near live parts. OSHA is adopting paragraph (b)(1) in this final rule without change from the proposal. This paragraph requires employees working on, or with, exposed energized lines or parts of equipment (at any voltage), and employees working in areas containing unguarded, uninsulated energized lines or parts of equipment operating at 50 volts or more, to be qualified employees. Without proper training in the construction and operation of the lines and equipment and in the electrical hazards involved, workers performing this type of work are at risk of being electrocuted and also may expose others to injury. In areas containing unguarded live parts energized at 50 volts or more, untrained employees would not be familiar with the practices that are necessary to recognize and avoid contact with these parts.

Commenting on the language in proposed paragraph (b)(1), Mr. Tommy Lucas with TVA questioned what OSHA means by "areas containing unguarded, uninsulated energized lines or parts of equipment" (Ex. 0213). He noted that the "area" at issue could be the room, yard, or building in which the equipment is located.

Paragraph (e) of § 1926.966 of the final rule contains requirements for guarding rooms containing electric supply equipment in substations. Paragraphs (u)(4) and (v)(4) of existing § 1910.269 contain corresponding requirements for maintenance work in substations and generating plants. These provisions generally require live parts operating at 50 volts or more to be in rooms or spaces enclosed within fences, screens, partitions, or walls so as to minimize the possibility that unqualified persons will enter. (See existing § 1910.269(u)(4)(ii) and (v)(4)(ii) and final § 1926.966(e)(2).) These are the areas to which final § 1926.960(b)(1)(ii) (and the corresponding requirement in final § 1910.269(l)(1)(ii)) refer.

The definition of "qualified employee" contains a note to indicate that employees who are undergoing on-the-job training are considered to be qualified if they have demonstrated an ability to perform duties safely and if they are under the immediate supervision of a qualified employee. (See the discussion of this definition under the summary and explanation of final § 1926.968.) Therefore, employees in training, who have demonstrated an ability to perform duties safely and are under the direct supervision of a qualified employee, are permitted to perform the types of work described in paragraph (b)(1). OSHA believes that close supervision of trainees will permit employers to correct errors before they cause accidents. Allowing these workers to perform tasks under workplace conditions also may better prepare the employees to work safely.

Paragraph (b)(2), which is similar to the last sentence of the introductory text of existing § 1910.269(l)(1), is being adopted in the final rule without change from the proposal. This paragraph requires lines and equipment to be considered and treated as energized unless they have been deenergized under the provisions of final § 1926.961. Existing § 1926.950(b)(2) requires electric lines and equipment to be considered energized until determined to be deenergized by tests or other appropriate means. The existing standard does not specify what those appropriate means are. However, even if the line or equipment is tested and found to be deenergized, it may become reenergized through contact with another source of electric energy or by someone reenergizing it at its points of control. So § 1926.961 of the final rule contains requirements for deenergizing electric power transmission and distribution lines and equipment. Unless the procedures contained in that section have been followed, lines and equipment cannot reliably be considered as deenergized.

Two-Person Rule

If an employee working on or near energized electric power transmission or distribution lines or equipment is injured by an electric shock, a second employee will be needed to provide emergency care to the injured employee. As noted under the summary and explanation of final § 1926.951(b), discussed earlier in this section of the preamble, CPR must begin within 4 minutes after an employee loses consciousness as a result of an electric shock. OSHA is requiring the presence of a second employee during certain types of work on or near electric power transmission or distribution lines or equipment to ensure that CPR begins as soon as possible and to help ensure that it starts within the 4-minute timeframe. (Note that final § 1926.951(b) requires at least two people trained in first-aid procedures, including CPR, for field work involving two or more employees at a work location.)

OSHA proposed, in paragraph (b)(3)(i) of § 1926.960, to require the presence of at least two employees during the following types of work:

(1) Installation, removal, or repair of lines energized at more than 600 volts,

(2) Installation, removal, or repair of deenergized lines if an employee is exposed to contact with other parts energized at more than 600 volts,

(3) 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,

(4) Work involving the use of mechanical equipment, other than insulated aerial lifts, near parts energized at more than 600 volts, and

(5) Other work that exposes an employee to electrical hazards greater than, or equal to, the electrical hazard posed by these operations.

However, OSHA also proposed exemptions to the two-person requirement to account for work that the Agency believed could be performed safely by a single employee or that must be performed as quickly as possible for public-safety purposes. These exemptions were proposed in paragraph (b)(3)(ii) for the following operations:

(1) Routine circuit switching, if the employer can demonstrate that conditions at the site allow safe performance of this work,

(2) Work performed with live-line tools if the employee is in a position from which he or she is neither within reach of nor exposed to contact with energized parts, and

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

OSHA based the proposed two-person rule on existing § 1910.269(l)(1)(i) and (l)(1)(ii). OSHA explained in the preamble to the proposal that the first four work operations listed in proposed paragraph (b)(3)(i) were the operations that expose employees to the greatest risk of electric shock, as demonstrated by the 1994 § 1910.269 rulemaking record (70 FR 34861). OSHA proposed the fifth and last category in paragraph (b)(3)(i) to cover additional types of work that pose equal or greater electrical hazards. The preamble to the proposal noted that operations covered under existing § 1910.269(l)(1)(i) are performed during construction, as well as during maintenance (*id.*). The preamble further noted that construction operations are similar to the operations performed during maintenance work and that the Agency believed that these operations involved the same hazards (*id.*). For example, using mechanical equipment near a 7200-volt overhead power line during construction of a new line poses hazards that are equivalent to the hazards posed during the use of mechanical equipment to replace a damaged pole on an existing line of the same voltage. Thus, OSHA proposed to extend the existing general industry requirement to construction.

The proposed requirement for at least two employees to be present during certain operations generally would not have applied if the voltage of the energized parts involved was 600 volts or less. In the proposal, OSHA requested comments on whether the final rule should extend the application of the two-person rule to any operations involving work on installations operating at 600 volts or less.

Most commenters opposed changing the proposed rule to require two persons for work on energized lines or parts operating at 600 volts or less. (See, for example, Exs. 0175, 0177, 0209, 0210, 0212, 0219, 0224, 0227.) Some of these rulemaking participants likened this work to the work performed by electricians, for which consensus standards do not require the presence of two people. (See, for example, Exs. 0175, 0209, 0212.) For instance, Ms. Salud Layton with the Virginia, Maryland & Delaware Association of Electric Cooperatives commented:

> We do not see the need for a second person on the job site for voltages below 600 Volts. . . . This work is generally easier and less hazardous. Work below 600 volts is generally similar to electricians work. Neither the NEC nor NESC require two employees to be present when working these voltages. Most electricians isolate themselves only thru the use of insulated tools. Utilities commonly exceed that level of protection by requiring the use of Class 0 gloves, in addition to the use of insulated tools. This combination effectively negates the need for a second person. The use of insulated tools with Class 0 gloves helps with protection and also eliminates the need for a second person. [Ex. 0175]

Mr. Allan Oracion with Energy United EMC similarly commented that work at voltages of 600 volts and less is less hazardous than work at higher voltages and that there is little potential for injury during "low-voltage" work as long as other applicable OSHA standards are followed (Ex. 0219). Others argued that a requirement for a second person would be costly and impractical without substantial benefits. (See, for example, Exs. 0177, 0224, 0227.) EEI commented:

> EEI submits that there is no need for further precautions to be required for such work, provided that the required insulated cover-up materials are used and personal protective equipment is being worn by employees while working on lines and equipment energized at less than 600 volts. One moderately sized utility forecasts that if it is required to replace existing one-person crews with two-person operations due [to] a revision in this requirement, the cost to the company would be approximately $ 3.8 million annually. OSHA has shown no data supporting a change in the requirements for work at less than 600 volts, including none showing that the benefit, if any, to be derived from unspecified additional precautions would be reasonably related to the cost. [Ex. 0227]

In responding to OSHA's request for comments on whether to require two persons for work at voltages of 600 volts or less, Consumers Energy noted that its accident experience indicated that employees who work alone have a significantly lower injury incidence rate than employees working together (Ex. 0177). Also on this issue, Siemens Power Generation commented that "OSHA should allow the employer to evaluate the hazard and determine which situations meet the need for a two person rule" (Ex. 0163).

Some commenters maintained that a second person *should* be present when work is performed on equipment energized at 600 volts or less. (See, for example, Exs. 0126, 0161, 0197, 0230.) Mr. Brad Davis of BGE suggested that "the same care should be taken at all voltage levels" (Ex. 0126). Mr. James Junga with Local 223 of the UWUA maintained that two persons should be required for all work on voltages of 480 volts or more, commenting:

> Working on secondary voltage at or above 480 volts should also require two qualified persons. I believe this voltage is extremely dangerous and should not be performed by one person [because of] the quick response that is necessary for a person who gets in contact with energized equipment operating at 480 volts. [Ex. 0197]

IBEW recommended that two-person crews always be required for construction work covered by Subpart V and that § 1910.269 be amended to include limitations on the work that can be performed by employees working alone on voltages of 600 volts or less, explaining:

> First and foremost, contractor crews, unless assigned only to perform minor maintenance, should never employ a one person crew. Contractor crews are generally performing new construction type work that usually requires several employees on each job. For the purposes of 1926 Subpart V, reference to a one person crew should not be included.
>
> For the purpose of 1910.269 and maintenance work, this section should be clarified. Just because the work involves voltages under 600 volts, there should be limitations as to how much a one person crew can perform. For example, the job requires open wire 1/0 aluminum secondary conductors that were burned down by a tree limb to be reinstalled up a pole. This will include clearing the downed tree parts, splicing the conductors, and sagging and dead-ending the conductors. Some of this work will even be performed de-energized, but exposure to other energized conductors is a possibility. There is no reason to put one person in this situation. [Ex. 0230]

OSHA does not agree with the comments suggesting that work on circuit parts energized at 600 volts and less is safe. When § 1910.269 was promulgated in 1994, the Agency concluded that there was "insufficient

evidence in the record as to whether or not it is safe for qualified employees to work alone on live parts energized at" 600 volts or less (59 FR 4381). In developing the subpart V proposal, OSHA examined more recent accident data. Table 5 shows the number of electrocutions for various voltage ranges for the years 1991 through 1998. In the years 1991 to 1994, an average of 3 fatalities occurred per year involving voltages of 600 volts or less. For the years 1995 to 1998, when § 1910.269 was fully in effect, the average dropped slightly to 2.5 fatalities per year.

TABLE 5—FATALITIES BY VOLTAGE AND YEAR

Year	600 V or less	601 V to 20 kV	20 to 80 kV	100 kV and higher
1991	3	24	2	1
1992	5	24	2	0
1993	3	23	3	1
1994	1	21	2	2
1995	2	22	4	5
1996	4	16	0	2
1997	1	6	3	1
1998	3	13	0	1

Source: OSHA database of electric power generation, transmission, and distribution accidents (Ex. 0004). These data include only cases involving electrocution in which the voltage was indicated in the accident abstract.

These data indicate that, in general, there is a substantial risk of death for employees working on voltages of 600 volts or less. Although it appears as though exposures to live parts energized at 600 volts or less result in relatively few accidents, OSHA concludes that these voltages are capable of killing workers. Consumers Energy's injury rates are not relevant here. The primary purpose of the two-person rule is the prevention of electrocution. Electrocutions are the result of electric shocks, which are a very low probability event, and have no significant effect on injury rates even when they occur in substantial numbers among all employees performing work addressed by the final rule.[172]

In addition, the types of work commonly assigned to crews of more than one employee include line installation and removal and the use of mechanical apparatus to lift or position material (59 FR 4380). This heavy type of work seems more likely to cause sprains and strains, lacerations, contusions, and scratches and abrasions, which form the majority of line worker injuries, than the lighter type of work commonly assigned to employees working alone, such as switching (Ex. 0081). OSHA, therefore, concludes that it is unlikely that the increased incidence rates experienced by Consumers Energy for employees working together are due to an increased incidence of electric shock. OSHA does not believe, and it is illogical to suggest, that an employee working alone is less likely to die as the result of an electric shock than an employee working in an environment in which another employee is available to provide emergency assistance in the event of a shock incident.

OSHA also disagrees with comments arguing that requirements for proper use of electrical protective equipment and other safety-related work practices make safe any work performed on circuit parts energized at 600 volts or less. The use of personal protective equipment and compliance with other OSHA-required work practices may well protect against hazards posed by these voltages; however, in the 1994 § 1910.269 final rule, the Agency adopted the two-person rule to *supplement* work practice and PPE requirements for certain types of electrical work.

In the rulemaking on the 1994 § 1910.269 final rule, OSHA examined the record to determine what operations posed sufficient residual risk to warrant the presence of a second person. The Agency found that some work involving installations operating at more than 600 volts posed hazards requiring the presence of a second person, but other work was safe enough for an employee to perform alone. In this rulemaking, OSHA is using the same approach to examine the need for a second person at voltages of 600 volts and less. Because there are relatively few accidents involving circuit parts energized at 600 volts or less, the Agency believes it is reasonable to assume, at these voltages, that there are few types of work that cannot be safely performed without the presence of a second person. However, OSHA agrees with IBEW that some low-voltage operations require at least two persons. There are many types of low-voltage work in which employees suffer electric shock, including installation, repair, and testing. Employees have sustained low-voltage electric shocks working on transformers, circuit breakers, and conductors.

Although the Agency is in general agreement with IBEW about the need for two persons for some work involving parts energized at 600 volts or less, OSHA decided not to require the presence of a second person during any specific types of work at such voltages because the record does not specifically indicate which low-voltage operations are hazardous enough to warrant a second-person requirement (except when a worker could contact lines or circuit parts energized at more than 600 volts while working on parts energized at less than 600 volts).

IBEW listed the following factors that limit when a one-person crew performs work: complexity of the tasks, hot-stick versus the rubber-glove work method, voltage-range limitations, limited time spent on a specific task, maintenance work only, and other factors (Ex. 0230). As already noted, with respect to low-voltage work, the union further commented:

> Just because the work involves voltages under 600 volts, there should be limitations as to how much a one person crew can perform. For example, the job requires open wire 1/0 aluminum secondary conductors that were burned down by a tree limb to be reinstalled up a pole. This will include clearing the downed tree parts, splicing the conductors, and sagging and dead-ending the conductors. Some of this work will even be performed de-energized, but exposure to other energized conductors is a possibility. There is no reason to put one person in this situation. [*Id.*].

[172] Electric shocks are responsible for a tiny proportion of the total number of injuries suffered by workers in the electric utility industry, as shown in "Assessment of the Benefits of the Proposed Standard on Electric Power Generation, Transmission, and Distribution; Coding Results and Analysis," which is an analysis of reports of injuries in the electric utility industry for calendar year 1989 (Ex. 0081). As this report shows, the leading categories for nature of injury are sprains and strains, lacerations, contusions, and scratches and abrasions, which together accounted for over 70 percent of the injuries. Electric shock accounted for only 0.7 percent of the injuries.

IBEW's comments do not provide the specificity about hazardous low-voltage tasks that the Agency determined is missing from the record. The purpose of the second-person requirement is to prevent fatalities from electric shock. Thus, the complexity of the job and time spent during the deenergized portion of the work have no bearing on the likelihood of an electric shock occurring and, accordingly, no bearing on whether OSHA should require a second person. Finally, in IBEW's specific example of low-voltage work, a second person is already required under the final rule if the employee is exposed to parts energized at more than 600 volts.[173] The remaining factors listed by IBEW do not appear to be related to the causes of low-voltage electrical accidents in the record. Although OSHA is not adopting any two-person requirements for work exposing employees to contact with lines or circuit parts energized at 600 volts or less, the Agency anticipates that, in certain situations, an employer will need to ensure that at least two trained persons are present for such work to satisfy the employer's obligations under the general duty clause of the OSH Act (Section 5(a)(1)). (See Chapter 4, Section III of OSHA's Field Operations Manual (FOM), CPL 02–00–150 (*http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=DIRECTIVES&p_id=4935*), for a discussion of general duty clause violations.)

IBEW pointed to new construction as an example of work necessitating the presence of more than one worker. New construction involves the installation of lines and equipment. Final paragraph (b)(3)(i) requires a second person for installation of lines or equipment if an employee is exposed to contact with other parts energized at more than 600 volts. IBEW's recommendation would also require a second person when an employee is exposed to electric-shock hazards of 600 volts or less and when electric-shock hazards are not present at all. OSHA decided against requiring a second person for lower voltage work for the reasons explained previously.

Mr. Junga recommended that the standard require a second person when "work is to be performed on electrical lines operating at primary voltages" (Ex. 0197). He stated:

> If a person working alone gets in contact with energized primary voltages and they are working alone they will die. No one will be there to assist, provide CPR, use an AED, provide first aid or even call for help. [*Id.*]

OSHA decided not to adopt Mr. Junga's recommendation. The Agency believes that the language adopted in final § 1926.960(b)(3)(i) adequately captures work in which employees are exposed to contact with parts energized at more than 600 volts (primary voltage). The exceptions to the two-person rule, adopted in final § 1926.960(b)(3)(ii), generally are limited to work that does not expose the employee to contact with parts energized at more than 600 volts.[174] OSHA believes that final § 1926.960(b)(3) ensures that employees at a substantial risk of electric shock are protected by the presence of a second person.

Mr. Daniel Shipp with ISEA recommended that OSHA require the presence of a second person whenever fall hazards are present in combination with electric-shock hazards (Ex. 0211). He pointed to risks associated with prolonged suspension in personal fall protection equipment, commenting:

> In a recent Safety and Health Information Bulletin, OSHA describes the hazard of prolonged suspension in a full body harness following a fall event. OSHA SHIB 03–24–2004 cites the hazard of orthostatic intolerance, recommending prompt rescue of suspended personnel, especially when other complicating factors may be present. A fall precipitated by exposure to an energized electrical source will require immediate rescue of the incapacitated employee and removal to a safe working level where medical aid can be administered. [*Id.*]

OSHA recognizes the hazards associated with prolonged suspension in full body harnesses. Therefore, § 1926.502(d)(20), which applies to personal fall arrest equipment, requires employers to provide for prompt rescue of employees in the event of a fall or assure that employees are able to rescue themselves. The Agency believes that final § 1926.960(b)(3) will assure the rescue of employees exposed to electric-shock hazards of more than 600 volts. Also, as explained previously, under Section 5(a)(1) of the OSH Act, employers may need to adopt additional measures beyond the measures required in final subpart V to assure prompt rescue of employees exposed to lower voltage electric-shock hazards. Because hazards associated with suspension in full body harnesses already are covered in § 1926.502(d)(20), OSHA sees no need to address them further in subpart V.

For all of these reasons, OSHA concludes that the evidence in this rulemaking record does not support adding a two-person requirement for any operation that existing § 1910.269(l)(1) permits an employee to perform alone.

Some commenters requested clarification of the relationship between the two-person rule in paragraph (b)(3) and the requirements on minimum approach distances, which are discussed later in this section of the preamble (Exs. 0209, 0230; Tr. 903). Mr. Thomas Frank of Ameren Corporation requested that OSHA revise the language so that the two-person rule applies only when an employee performs work within the applicable minimum approach distance (Ex. 0209). In addition, Mr. Edwin Hill with IBEW suggested that there is confusion in the industry about the applicability of minimum approach distances to employees working alone, commenting:

> The current language in 1910.269 is many times misunderstood. [S]ome people believe that a worker can get closer than the minimum approach distance to an energized primary conductor when working alone. This should not be true. . . .
>
> If the standard is going [to] allow a one person crew to work around energized primary conductors of voltages greater than 600 volts, then it should be clear that minimum approach distances must be maintained. In the case of underground distribution equipment, the same detailed restrictions should be explained. Many times during an underground circuit outage, a worker opens the equipment doors and is within the minimum approach distances of the energized cables, both "live front terminations" and "dead front elbows". The established minimum approach distances should be maintained at all times, in any work situation, to ensure worker safety. If these distances cannot be maintained, rubber insulating cover-up equipment should be installed. [Ex. 0230]

In this regard, paragraph (b)(3) does not excuse compliance with otherwise applicable minimum approach-distance requirements. OSHA previously clarified existing § 1910.269(l)(1), from which it adopted final paragraph (b)(3), explaining that an employee is "exposed to contact" for purposes of § 1910.269(l)(1) when he or she is in a working position from which he or she can reach or take a conductive object within the electrical component of the minimum approach distance.[175] (See the summary and explanation for final § 1926.960(c)(1) later in this section of the preamble for a discussion of the

[173] Final paragraph (b)(3)(i)(B) requires the presence of a second employee when an employee installing deenergized lines is exposed to contact with parts energized at more than 600 volts. The operating voltage of the deenergized line has no bearing on whether a second person is required.

[174] Under final § 1926.960(b)(3)(ii)(C), one employee working alone may perform emergency repair work involving parts energized at more than 600 volts, but only to the extent necessary to safeguard the general public.

[175] See the letter of interpretation dated October 18, 1995, to Mr. Lonnie Bell, *http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=21981*.)

electrical component of the minimum approach distance.) OSHA notes that an employee who is "exposed to contact" with an energized part under this interpretation is still "exposed to contact" with the energized part even when insulation covers the part, the employee, or both. (See final §§ 1910.269(x) and 1926.968 (defining "exposed" as not isolated [176] or guarded;[177] merely covering a conductor or an employee with insulation does not provide guarding or isolation).) [178] The Agency also notes that a second employee may be required when employees can reach or take a conductive object into the electrical component of the minimum approach distance as they are approaching or leaving their final work positions or moving from one work position to another.

Mr. Junga with UWUA Local 223 was concerned that "[e]mployers are pushing for more one-person crews and asking [them] to do more [of] the work that historically has been performed by two or more qualified persons" (Ex. 0197).

In response, OSHA reiterates that the exceptions from the two-person rule, which are specified in final paragraph (b)(3)(ii) and are based on existing § 1910.269(l)(1)(ii), will be interpreted and applied narrowly. Paragraph (b)(3)(ii)(A) permits an employee to work alone to perform routine circuit switching, as long as the employer can demonstrate that conditions at the site allow safe performance of this work. Employees have been injured during switching operations when unusual conditions, such as poor lighting, bad weather, or hazardous configuration or state of repair of the switching equipment, were present (269-Ex. 9–2). If there is poor lighting, for example, the employer may be unable to demonstrate that the operation can be performed safely by one employee; the employer could, however, elect to provide supplemental lighting adequate to make it safe for an employee to work alone.

Paragraph (b)(3)(ii)(B) permits one employee to work alone with live-line tools if the employee is positioned so that he or she is neither within reach of, nor otherwise exposed to contact with, energized parts. Accidents involving hot-stick work have typically occurred only when the employee was close enough to energized parts to be injured—either through direct contact or by contact through conductors being handled (269-Ex. 9–2).

Finally, paragraph (b)(3)(ii)(C) permits one employee to work alone on emergency repairs necessary to safeguard the general public. OSHA will generally consider situations in which there is a downed energized power line, an energized power line on an occupied vehicle, or a service outage to life-support equipment to be emergency situations for which an employee can work alone to safeguard the public. Whether outages to street lights, traffic lights, or homes are emergency situations for purposes of final paragraph (b)(3)(ii)(C) depends on many factors, including the extent and expected duration of the outage and the availability of alternative means of protecting the public, such as the availability of police or other officials to manage or stop traffic at intersections in the absence of working stoplights. Because hospitals and similar patient-care facilities usually have backup generators, outages of circuits supplying these facilities will not generally be deemed to fall under final paragraph (b)(3)(ii)(C).

Minimum Approach Distances

Paragraph (c)(1) in the final rule sets requirements for minimum approach distances. Paragraph (c)(1)(i) requires employers to establish minimum approach distances no less than the distances computed by the equations set in Table V–2 for ac systems or Table V–7 for dc systems. (The equations in Table V–2 in the final rule are described and explained later in this section of the preamble.) Paragraph (c)(1)(iii) of the final rule requires the employer to ensure that no employee approaches, or takes any conductive object, closer to exposed energized parts than the employer's established minimum approach distance, except as permitted in paragraphs (c)(1)(iii)(A), (c)(1)(iii)(B), and (c)(1)(iii)(C) (as explained later in this section of the preamble).

Table V–2 provides equations for the employer to use to compute minimum approach distances under paragraph (c)(1)(i). The equations vary depending on voltage and, for phase-to-phase voltages of more than 72.5 kilovolts, on whether the exposure is phase-to-phase or phase-to-ground.

Paragraph (c)(1)(ii) in the final rule provides that, no later than April 1, 2015, for voltages over 72.5 kilovolts, the employer 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. The employer must make any engineering analysis conducted to determine maximum anticipated per-unit transient overvoltage available upon request to affected employees and to the Assistant Secretary or designee for examination and copying. When the employer uses portable protective gaps to control the maximum transient overvoltage, final paragraph (c)(1)(ii) also requires that 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.

Under Appendix B to existing § 1910.269, employers use engineering analyses to determine any reductions in maximum transient overvoltages below the maximum values listed in Table R–7 and Table R–8. Also under Appendix B to existing § 1910.269, when an employer is using portable protective gaps, it determines minimum approach distances using a specific methodology

[176] The proposed rule and existing § 1910.269 did not define "isolated." However, existing Subpart V did define that term in § 1926.960 as "not readily accessible to persons unless special means of access are used." This definition is identical to the definition of this term in OSHA's electrical standards for general industry (§ 1910.399) and construction (§ 1926.449) and in the 2002 NESC (Ex. 0077). This definition also is consistent with the use of the term "exposed to contact" in final paragraph (b)(3). OSHA believes that defining "isolated" will help clarify the final rule. Consequently, OSHA included the definition of "isolated" in final §§ 1910.269(x) and 1926.968. The Agency also included "exposed to contact" as a synonym in the definition of "exposed" to clarify that the definition of "exposed" also applies to the term used in final paragraph (b)(3).

[177] Section 1926.968 defines "guarded" as "[c]overed, 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." Subpart V recognizes two methods of guarding: barriers (or enclosures), which serve to "minimize the possibility . . . of . . . inadvertent contact," and guarding by location, which serves to "minimize the possibility . . . of dangerous approach." As explained in the note to final § 1926.966(f)(1), the 2002 NESC contains guidelines for the dimensions of clearance distances about electric equipment in substations. OSHA considers these clearance distances as minimizing the possibility of dangerous approach for employees and considers energized parts conforming to the clearance distances in the 2002 NESC to be guarded, unless employees bypass those distances (for example, by accessing a "guarded" area). (See also the summary and explanation for final § 1926.966(f)(1) later in this section of the preamble.)

[178] IEEE Std 516 further clarifies the treatment of insulated cables (Exs. 0041, 0532). For example, Section 4.9.1 of IEEE Std 516–2009 states:

The following are considered to be live parts at their normal operating voltage unless they are properly grounded:

* * * * *

—Conductors—insulated unless they have solidly grounded and tested shields (The condition of the conductor insulation exposed to weather is unknown and may be damaged or defective.) [Ex. 0532]

that provides 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 at the worksite. OSHA incorporated both of these performance requirements in final paragraph (c)(1)(ii). To explain terms used in final paragraph (c)(1)(ii), OSHA also added definitions of "statistical sparkover voltage" and "statistical withstand voltage" to final § 1926.968. Statistical sparkover voltage is a transient overvoltage level that produces a 97.72-percent probability of sparkover (in other words, two standard deviations above the voltage at which there is a 50-percent probability of sparkover). Statistical withstand voltage is a transient overvoltage level that produces a 0.14-percent probability of sparkover (in other words, three standard deviations below the voltage at which there is a 50-percent probability of sparkover). OSHA based both definitions on definitions in IEEE Std 516–2009 (Ex. 0532).

Table V–7 contains minimum approach distances for dc systems. In Table V–7, the applicable minimum approach distance depends on the maximum anticipated per-unit transient overvoltage and the maximum line-to-ground voltage. In accordance with final paragraph (c)(1)(ii) and Table V–8, an employer using Table V–7 must determine the maximum anticipated per-unit transient overvoltage through an engineering analysis that is made available upon request to affected employees and to the Assistant Secretary or designee for examination and copying or must assume a maximum per-unit transient overvoltage of 1.8.

Paragraph (c)(1)(i) makes it clear that the required minimum approach distances are based on engineering principles that OSHA adopted in the final rule. The Agency is adopting the equations and the engineering principles behind the minimum approach distances rather than just setting distances as it did when it promulgated § 1910.269 in 1994. This paragraph also ensures that the minimum approach distance maintained by each employee is appropriate for the workplace rather than for the industry in general. OSHA believes that this approach will better protect each employee than existing § 1910.269 and the proposed rule.

The minimum approach distances set by Table V–2 for phase-to-phase system voltages of 72.5 kilovolts and less do not vary based on worksite conditions provided the altitude is 900 meters (3,000 feet) or less above sea level. Therefore, OSHA calculated the minimum approach distances for these voltages and listed them in Table V–5 in the final rule. Note 1 in Table V–2 provides that, for voltages up to 72.5 kilovolts, employers may use the precalculated minimum approach distances in Table V–5 provided the worksite is at an elevation of 900 meters or less.

Minimum approach distances for phase-to-phase system voltages of more than 72.5 kilovolts will vary depending on conditions present at the worksite and possibly the work practices used by employees. Parameter *C* in the equation for these voltages varies depending on whether an insulated tool or conductive object is in the approach distance (gap) between the employee and the energized part (if the employee is at ground potential or at the potential of a different energized part) or between the employee and ground (if the employee is at the potential of the energized part). For phase-to-ground exposures, if the employer can demonstrate that there is only air in this gap, then *C* equals 0.01. For phase-to-phase exposures, if the employer can demonstrate that no insulated tool spans the gap and that no large conductive object is in the gap, then *C* equals 0.01. In all other cases, *C* equals 0.011. When an employee is climbing on a structure or performing live-line barehand work, OSHA expects that there normally will only be air present in the gap, and the equation will produce a smaller minimum approach distance than if the employee is using an insulated tool to work on energized parts.[179]

The saturation factor, *a*, in the equation for system voltages of more than 72.5 kilovolts varies depending on whether the exposure is phase-to-ground or phase-to-phase. For phase-to-ground exposures, the saturation factor will be reduced slightly, resulting in smaller minimum approach distances. As explained in Note 3 in Table V–2, unless the employer can demonstrate that no insulated tool spans the gap and that no large conductive object is in the gap, the employer must calculate the saturation factor using the phase-to-ground equations (with the peak voltage for phase-to-phase exposures), even for phase-to-phase exposures.

Finally, T[180] in the equation for phase-to-phase system voltages of more than 72.5 kilovolts represents the maximum phase-to-ground anticipated per-unit transient overvoltage, which can vary from worksite to worksite.

For voltages over 72.5 kilovolts, employers may use the minimum approach distances in the tables in Appendix B provided the worksite is at an elevation of 900 meters or less. The tables in Appendix B contain minimum approach distances for various values of *T*. In accordance with final paragraph (c)(1)(ii), the employer must determine *T* through engineering analysis or use the maximum *T* from Table V–8.

For phase-to-phase system voltages of more than 5,000 volts, the altitude-correction factor applies when the worksite is at an elevation of more than 900 meters above sea level. When the worksite is at these higher elevations, the employer must use the appropriate altitude correction factor from Table V–4 when calculating minimum approach distances. Table V–2 explains how to apply the altitude correction factors in computing minimum approach distances.

As noted earlier, paragraph (c)(1)(i) requires employers to establish minimum approach distances. Because the elevation and maximum transient overvoltage may vary from worksite to worksite, each minimum approach distance established by the employer must be appropriate for the worksite involved. Employers can avoid establishing separate distances for every worksite by using worst-case values for elevation and *T* or by grouping worksites by ranges for elevation and *T*.

Paragraph (c)(1) of proposed § 1926.960 would have required employers to ensure that employees maintain minimum approach distances from exposed energized parts. Proposed Table V–2 through Table V–6 specified the minimum approach distances. This proposed provision was borrowed from existing § 1910.269(l)(2), although, as described later, OSHA proposed to make minor changes to the minimum approach distances listed in the existing § 1910.269 tables.

Electric power systems operate at a given nominal voltage. However, the actual voltage on a power line varies above and below that nominal voltage. For brief periods, the instantaneous voltage on a line can be 3 or more times its nominal value (Ex. 0532).

The safe minimum approach distance assures that an electric arc will not

[179] Live-line barehand work is work performed with the employee at the same potential as one of the phase conductors. The employee is insulated, by air or another insulating medium, from the other phase conductors and from ground.

[180] *T* is the ratio of the 2-percent statistical switching overvoltage expected at the worksite to the nominal peak line-to-ground voltage of the system.

form, even under the most severe transient overvoltages that can occur on a system and even when the employee makes errors in maintaining the minimum approach distance. To determine what this distance is for a specific voltage, OSHA must first determine the size of the air gap that must be present to prevent arc-over during the most severe overvoltage that can reasonably be expected to occur on the system. This gap is the electrical component of the minimum approach distance. To determine the minimum safe approach distance, OSHA must add extra distance to account for ergonomic considerations (that is, human error).

The electrical component depends on five factors:

(1) The maximum voltage,

(2) The wave shape of this voltage,

(3) The configuration of the "electrodes" forming the end points of the gap,

(4) The insulating medium in the gap, and

(5) The atmospheric conditions.

In existing § 1910.269, and in the proposal for this rulemaking, OSHA borrowed its approach for setting minimum approach distances from a consensus standard, namely the NESC. OSHA based the minimum approach distances in existing § 1910.269 on the 1993 edition of the NESC. In this rulemaking, OSHA proposed to adopt slightly revised minimum approach distances for both § 1910.269 and subpart V; the revised minimum approach distances in the proposal were drawn from the updated, 2002 edition of the NESC.

To develop the minimum approach distance tables for the 1993 standard, NESC Subcommittee 8 adopted the following principles:

- ANSI/IEEE Std 516 was to be the electrical basis of the NESC Rules for approach distances for alternating- and direct-current voltages above 72.5 kilovolts.[181] Distances for lower voltages were to be based on ANSI/IEEE Std 4. The application of ANSI/IEEE Std 516 included the formula used by that standard to derive electrical clearance distances.
- Altitude correction factors were to be in accordance with ANSI/IEEE Std 516.
- The maximum design transient-overvoltage data to be used in the development of the basic approach distance tables were:
  - 3.0 per unit for voltages of 362 kilovolts and less
  - 2.4 per unit for 500 to 550 kilovolts
  - 2.0 per unit for 765 to 800 kilovolts
- All phase-to-phase values were to be calculated from the EPRI Transmission Line Reference Book for 115 to 138 kilovolts.
- An ergonomic-movement factor (inadvertent component) that accounted for errors in judging the approach distance was to be added to all basic electrical approach distances (electrical component) for all voltage ranges. A distance of 0.31 meters (1 foot) was to be added to all voltage ranges for the ergonomic component. An additional 0.3 meters (1 foot) was to be added to voltage ranges below 72.6 kilovolts.
- The voltage reduction allowance for controlled maximum transient overvoltage was to be such that the minimum allowable approach distance was not less than the approach distance specified for the highest voltage listed for the given range.
- The transient overvoltage tables were to be applied only at voltage ranges inclusive of 72.6 to 800 kilovolts. All tables were to be established using the higher voltage of each separate voltage range.

After publication of OSHA's proposed rule in 2005, the IEEE technical committee responsible for revising Standard 516 identified what in its view was an error in calculating the minimum approach distances in the IEEE standard that potentially affected the validity of the minimum approach distances in the 2002 NESC and OSHA's proposed rule. IEEE Std 516 was revised in 2009 to address the issue identified by the technical committee. (The error identified by the IEEE committee is discussed, at length, later in this section of the preamble.) In light of the IEEE revision process, OSHA twice reopened the record on subpart V, first in October 2008 and again in September 2009, to solicit additional comments on minimum approach distances. (See 73 FR 62942, Oct. 22, 2008; 74 FR 46958, Sept. 14, 2009.) The Agency requested information on whether there was an error in the method OSHA used to calculate the proposed minimum approach distances and on what basis OSHA should set minimum approach distances. A public hearing was held on these issues in October 2009.

In response to the issues OSHA raised about the minimum approach distances, EEI, IBEW, and the NESC urged the Agency to delay issuing revised minimum approach distances until after IEEE approved the next update of the NESC in 2012.[182] (See, for example, Exs. 0545.1, 0551.1, 0552.1; Tr2. 40–41, 72–75, 151–154.) The commenters maintained that, in writing the respective standards, the NESC subcommittees give greater weight to the practical effects of its rules than does the IEEE subcommittee responsible for IEEE Std 516. The commenters also maintained that an OSHA standard setting minimum approach distances that turn out to be different from the distances in the 2012 NESC could cause confusion.

The chair of Subcommittee 8 of the NESC, Mr. James Tomaseski, testified that the NESC serves as the authority on safety requirements for electric power systems, that (at the time of his testimony) the NESC had yet to act on the revised methodologies in IEEE Std 516–2009 for calculating minimum approach distances, and that NESC Subcommittee 8 would transcribe the engineering information contained in the 2009 IEEE 516 standard into a user-friendly format (Tr2. 34–41).[183] He stated:

> NESC's Subcommittee 8 has the task of trying to make sense of and keep up with this evolving problem [of adopting adequate minimum approach distances]. Simply put, the IEEE 516 MAD Tables as they are published today in that [2009] guide are confusing.
>
> This takes us to the point what Subcommittee 8 recommends to OSHA for this Rule making. The agency should realize this is a difficult issue, not only for the Technical Subcommittee responsible for the different Codes, but most importantly for the users of the Rules. The MAD concept has been around for a long time. Even though new engineering principles continue to be developed, industry performance associated with these rules [has] to be considered.
>
> * * * * *
>
> When OSHA revise[s] this Rule, these changes are somewhat permanent. This rule will probably not be revised again for a long time. Subcommittee 8 wants to do their part to make sure the MAD [c]oncepts get fixed correctly this time. The NESC Subcommittee 8 recommends that OSHA leave the record open until the time the Subcommittee has the opportunity to review public comments as to what MAD values should be in the NESC. [Tr2. 39–41]

IBEW also maintained that the OSHA standard should be consistent with the 2012 NESC (Tr2. 151–152). Testifying on behalf of IBEW, Mr. Donald Hartley stated:

[181] ANSI/IEEE Std 516–1987 (the edition in effect when NESC Subcommittee 8 revised the minimum approach distances for the 1993 NESC) listed values for the electrical component of the minimum approach distance, both for air alone as an insulating medium and for live-line tool sticks in air, that were accepted as being accurate when the standard was adopted (by IEEE) in 1987.

[182] IEEE approved the 2012 NESC on April 14, 2011, and ANSI approved the 2012 NESC as an American National Standard on June 3, 2011.

[183] The 2012 NESC adopts the 2009 IEEE Std 516 distances for certain voltage ranges and values of T and permits an engineering determination of minimum approach distances as an alternative.

The IBEW believes the responsibility for developing [minimum approach distances resides with] the NESC. Technical Subcommittee 8 on Work Rules, the body responsible for writing Part IV of the NESC where MAD Rules and Tables are located, should [set the rules] for OSHA to follow.

The NESC is adopted by many states in the U.S. The U.S. [Rural] Electric Service requires member cooperatives to follow the NESC if they receive government loans. Many public power utilities, municipalities are not covered by OSHA. The NESC in these instances becomes the rule to follow.

* * * * *

The IBEW strongly recommends that OSHA keep this record open until Subcommittee 8 has the opportunity to review public comment on this issue and develop final Code Language on the MAD principles and Rules. [*Id.*]

EEI argued that, if OSHA failed to follow NESC action on minimum approach distances, the final rule could differ from the 2012 NESC and create confusion for the electric utility industry (Ex. 0545.1). Mr. Stephen Yohay, counsel for EEI, described the potential for confusion over differing standards as follows:

The other question you asked is whether [there is] confusion in the industry [resulting from the fact that there are currently differences between the minimum approach distances in the existing OSHA standards and the distances in the consensus standards], and I am going to answer this anecdotally based on my experience in representing employers in this industry.

I have often, not often, but more than occasionally heard confusion expressed as to which standards are the applicable standards, whether they are the OSHA standards, whether they are the NESC standards. And as you heard Mr. Tomaseski say various companies adopt different [distances] for their own work practices.

Now when you throw in the element of State plans, you further confuse the mix. So I think there is some confusion and I think you all heard him say here earlier, and I think we all agree it is time for there to be consistency. [Tr2. 102–103]

EEI also pointed out that Section 6(b)(8) of the OSH Act requires OSHA to explain deviations from national consensus standards (Ex. 0545.1). Mr. Charles Kelly testified to this point on behalf of EEI, as follows:

Section 6(b)(8) of the Act expresses that OSHA standards should not deviate from National Consensus Standards without an adequate statement of reason.

The NESC Committee may or may not adopt the precise distances stated in the IEEE documents. Therefore, if OSHA incorporates the IEEE distances in a final standard that is promulgated in the next year or so, OSHA [may] soon find its final standard at odds with even the newest version of the NESC.

The NESC, however, is well recognized as the preeminent National Consensus Standard on clearance distances for electric utility work on high voltage lines and equipment. Such a result could only create confusion in the industry. [Tr2. 73]

Mr. Kelly also maintained that the NESC gives greater weight to the practical application of its rules than does IEEE and that OSHA should adhere to its past practice of basing its rules for minimum approach distances on the NESC, testifying:

[B]y virtue of the nature of its membership and the mission of its Subcommittee 8, we daresay with due respect to IEEE Committee 516, that the NESC's final standards on Work Rules tend to give more attention to the practical impact that its Rules will have in the workplace than do IEEE Technical Standards.

[T]he 516 Standard is basically an engineering standard and built that way on the technical issues whereby the NESC Subcommittee 8 Standard; it deals with the Work Rules and Worker Protection more specifically.

* * * * *

The usual cycle, and as I mean the historical cycle that OSHA has followed, is that the IEEE 516 Standard develops its standard, ballots it and publishes the standard over a period of time.

The NESC Subcommittee 8 reviews 516, develops their standard, tables, ballots, and publishes it in that order. Then OSHA usually comes in and reviews the documented proof by both groups, and incorporates the NESC document into its particular Rule.

The above scenario reflects the past practices used by OSHA in its development of standards affecting electric power generation, transmission, and distribution work. [Tr2. 73–74]

Although the Agency considered the commenters' suggestion to hold the record for this rulemaking open until IEEE approved the 2012 NESC, OSHA concludes that it is unnecessary to reopen the record to consider the 2012 NESC in this rulemaking. First, OSHA does not agree that adopting minimum approach distances that differ from the distances in the 2012 NESC will produce widespread confusion or lead to additional risk for employees in the electric power industry. As acknowledged by some of the rulemaking participants, the distances in existing § 1910.269 and Subpart V differed from the 2009 edition of the NESC. (See, for example, Tr2. 53, 102–103.) In fact, Mr. Tomaseski presented slides showing that there were many differences between the NESC, IEEE Std 516, and the OSHA standards (Ex. 0568). Rulemaking participants testified that they were not aware of any specific safety problems arising in the industry by virtue of these discrepancies. (See, for example, Tr2. 58, 102, 104). Also, counsel for EEI admitted that "[e]mployers are at least following OSHA standards. . . . Some are exceeding the values that are in the OSHA standards and adopting more conservative standards" (Tr2. 104). In any event, evidence in the record indicates that consensus standards are constantly evolving (see for example, Tr2. 39–40, 142–143); therefore, if the Agency were to adopt the minimum approach distances from the 2012 NESC, it is likely that there would be differences between the OSHA standard and subsequent editions of the NESC.

OSHA does not believe there is merit to the commenters' suggestion that the existence of State plan programs will be an additional source of confusion for employers. As noted in Section XI, State-Plan Requirements, later in this preamble, States with OSHA-approved occupational safety and health plans must adopt standards that are equivalent to, and at least as protective as, this final rule within 6 months of its promulgation. Thus, States with State plans will adopt provisions on minimum approach distances that are at least as protective as the provisions in this final standard. On a technical issue such as minimum approach distances, OSHA expects that most States with State plans will choose to incorporate the federal provision as promulgated in this final rule, although it is possible that one or more of these States will adopt more protective provisions. Even if some States do adopt more protective standards, OSHA does not believe that the resultant differences will result in any significant confusion for employers.

Public electric utilities in States with State occupational safety and health plans, including plans that cover only State and local government employees, will be required to comply with the applicable State plan standards. Public electric utilities in other States are not covered by a State plan or by the Federal OSHA standard and may choose to adhere to the NESC. Private-sector electric utilities must comply with the Federal or State plan OSHA standards that cover their worksites. This scheme is well established, and OSHA does not believe that employers will have difficulty determining the applicable requirements.

As noted earlier, IBEW suggested that a conflict between the OSHA and the 2012 NESC minimum approach distances could be problematic for loan recipients in the United States Department of Agriculture's (USDA) Rural Development Electric Programs because, according to the union, utilities receiving USDA loans must comply with the NESC as a condition of their loans (Tr2. 151). These USDA programs

provide loans for electric services that meet certain standards, and IBEW is correct that the NESC is among the standards that these services must meet (7 CFR 1724.50). However, even if the loan programs require compliance with the minimum approach distances in the NESC, employers can meet both the OSHA and USDA loan-program requirements simply by adopting the more conservative (that is, larger) minimum approach distances. Therefore, differences between the minimum approach-distance provisions in this final rule and the minimum approach distances in the 2012 NESC should not be a problem for participants in the USDA programs.

Second, the Agency does not believe that considering public input on the 2012 NESC will result in a standard that is more protective than the final rule. The NESC minimum approach distances are based on the minimum approach distances in IEEE Std 516–2009, on which OSHA already solicited public comment and provided opportunity for additional input at a public hearing (74 FR 46958). The 2012 NESC does not include any additional support for the IEEE minimum approach distances, which, as explained later in this section of the preamble, OSHA rejected. In addition, reopening the record for this rulemaking would further delay the final rule. Therefore, OSHA concludes that reopening the record to gather additional public comment on the 2012 NESC minimum approach distances is unwarranted.

Finally, in response to the commenters' references to Section 6(b)(8) of the OSH Act the Agency concludes that, with respect to minimum approach distances, this final rule "will better effectuate the purposes of [the] Act" than the 2012 edition of the NESC. (See the discussion under the heading *OSHA's requirements on minimum approach distances better effectuate the purpose of the OSH Act than the national consensus standard,* later in this section of the preamble.)

Some commenters maintained that the minimum approach distances in the 2005 proposed rule, which were based on the 2002 NESC, were safe despite any technical errors potentially made in calculating those distances. (See, for example, Ex. 0545.1; Tr2. 79–82.) The commenters argued that industry experience establishes the safety of the existing minimum approach distances in § 1910.269. (See, for example, Exs. 0545.1, 0551.1.)

American Electric Power argued against adopting minimum approach distances different from the minimum approach differences in OSHA's proposal, relying on calculations they made that were taken from a paper by Vaisman et al.[184] (Ex. 0550.1). American Electric Power described this method as follows:

> The method is based on calculating $V_{50\%}$ (critical flashover[185] voltage—CFO) and determining distances from the $V_{50\%}$ value of conductor-to-conductor gap test data. The $V_{50\%}$ is derived from the required V_W (withstand voltage), using the line-to-line overvoltage factor, T_{L-L}. The required distance for [minimum air insulation distance] and MAD is then taken from . . . Figure 13 in an IEEE paper by Vaisman [footnote omitted] et al., 1993, which represents conductor-to-conductor gap test data from five different laboratories. The test data is based on $\alpha = 0.50$ (ratio between the negative impulse crest and the phase to phase voltage) which provides more conservative results for $V_{50\%}$ than $\alpha = 0.33$ (Figure 12 of the aforementioned Vaisman paper). [*Id.*]

American Electric Power calculated $V_{50\%}$ to be 2421 kilovolts for an 800-kilovolt power line (*id.*). From Figure 13 of the Vaisman paper, American Electric Power determined that the corresponding minimum air-insulation distance (the electrical component of the minimum approach distance) was 6.52 meters (21.4 feet) and that the minimum approach distance (with the ergonomic component included as explained later in this section of the preamble) was 6.82 meters (22.4 feet). American Electric Power contrasted this with the corresponding 7.91-meter (26-foot) minimum approach distance proposed by OSHA and concluded that the proposed value was adequately protective (*id.*). (See, also, Ex. 0545.1, in which EEI makes a similar argument based on the Vaisman paper.)

As explained in greater detail later in this section of the preamble, OSHA concludes that the proposed minimum approach distances do not provide adequate safety for employees. In addition, OSHA finds that there are two basic problems with American Electric Power's comparison of the proposed 800-kilovolt minimum approach distance and what it considers to be a safe approach distance. First, as is clear from the Vaisman paper (Ex. 0555), the distances in Figure 13 of that paper (which correspond to $\alpha = 0.50$) are less conservative than the distances in Figure 12 of that paper (corresponding to $\alpha = 0.33$).[186] The air-insulation distance from Figure 12 appears to be about 7.8 meters (25.6 feet). Adding the 0.31-meter (1-foot) ergonomic component yields a comparable minimum approach distance of 8.11 meters (26.6 feet), which is clearly more protective than the 7.91-meter (26-foot) minimum approach distance proposed by OSHA in 2005.[187]

Second, the testing that serves as the basis for Figures 12 and 13 of the Vaisman paper determined the switching impulse strength of two conductors in parallel (Ex. 0555). From the paper's description of the test procedure, OSHA concludes that the testing did not account for different configurations that could be present during live-line work or for the presence of workers and the tools and equipment they would be using to perform this work. As explained later in this section of the preamble, different electrode configurations and the presence of workers and other conductive objects in the gap between them can reduce the electrical strength of the air gap substantially. Thus, although American Electric Power's and EEI's approach may validly estimate the strength of a power line while no work is being performed, OSHA concludes that this approach fails to represent employee exposure adequately.

For reasons described later in this section of the preamble, the Agency concludes that there is a significant risk to employees from the minimum approach distances contained in existing § 1910.269 and Subpart V. In addition, OSHA concludes that it has enough information in the rulemaking record to set appropriate minimum approach-distance requirements.

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[184] Vaisman, R., Fonseca, J. R., Andrade, V. H. G., Almeida, M. A., Hattori, H. K., Melo, M. O. B. C., Teivelis, F., Fernandes, J. H. M., Silva, J. T. S., Dias, L. E. N., Esmeraldo, P. C. V., and Samico, R. A. M., "Switching Impulse Strength of Compact Transmission Lines," *IEEE Transactions on Power Delivery,* Vol. 8, No. 3, July 1993 (Ex. 0555).

[185] IEEE Std 516–2009 defines "flashover" as "[a] disruptive discharge through air around and over a surface of solid or liquid insulation, between parts at different potential or polarity, produced by application of voltage wherein the breakdown path becomes sufficiently ionized to maintain an electric arc" (Ex. 0532). That standard defines "sparkover" as "[a] disruptive discharge between preset electrodes in either a gaseous or a liquid dielectric" (*id.*). Thus, the more technically correct term for an electrical discharge across an air gap is "sparkover." However, the term "flashover" has been used historically for either event, and this preamble uses these terms interchangeably. The critical flashover distance, V_{50} or $V_{50\%}$, is the distance that will flashover 50 percent of the time at a given voltage.

[186] American Electric Power commented that an α of 0.50 "provides more conservative results for $V_{50\%}$ than $\alpha = 0.33$" (Ex. 0550.1). This comment may be true, but it is irrelevant. For a given $V_{50\%}$, an α of 0.33 produces a more conservative (that is, greater) minimum approach distance, as is the case here.

[187] The quality of Figures 12 and 13 in the original Vaisman paper is poor, and it is difficult to accurately determine the distance (Ex. 0555). The figures included in American Electric Power's and EEI's exhibits, which apparently recreated Figure 13 from the Vaisman paper, were of much better quality (Exs. 0550.1 and 0545.1).

Consequently, the Agency decided that it is necessary and appropriate to include revised minimum approach-distance provisions in this final rule.

The ergonomic component of MAD. The ergonomic-movement component of the minimum approach distance is a safety factor designed to ensure that the employee does not breach the electrical component of the minimum approach distance in case he or she errs in judging and maintaining the minimum approach distance. In developing the minimum approach distance tables for its 1993 standard, the NESC subcommittee based the ergonomic-movement factor (the ergonomic component of MAD) on relevant data, including a typical arm's reach of about 610 millimeters (2 feet) and a reaction time to a stimulus ranging from 0.2 to more than 1.0 second (269-Ex. 8–19). As OSHA explained in the preamble to the proposal, the ergonomic-movement factor must be sufficient for the employee to be able to recognize a hazardous approach to an energized line and withdraw to a safe position so that he or she does not breach the air gap required for the electrical component of the minimum approach distance (70 FR 34862). Thus, the ergonomic-movement distance should equal the response time multiplied by the average speed of an employee's movement plus the stopping distance.[188] The maximum reach (or range of movement) may place an upper bound on the ergonomic component. The NESC subcommittee developing the 1993 standard used this information as a basis for selecting appropriate distances for two major voltage ranges: 1.1 to 72.5 kilovolts and 72.6 kilovolts and more.

For system voltages up to 72.5 kilovolts, phase-to-phase, much of the work is performed using rubber gloves, and the employee is working within arm's reach of energized parts. The ergonomic component of the minimum approach distance must account for this condition since the employee may not have time to react and position himself or herself out of danger. A distance of 0.61 meters (2 feet) for the ergonomic component appears to meet this criterion and was, therefore, adopted by the NESC subcommittee developing the 1993 standard. This ergonomic component remained the same in the 2007 NESC, except that the standard applied it to voltages as low as 751 volts instead of 1100 volts (Ex. 0533).[189] OSHA used this value in existing § 1910.269 for voltages of 1.1 to 72.5 kilovolts and proposed to use it in Subpart V for voltages of 751 volts to 72.5 kilovolts. There were no objections to this distance on the record.[190] Therefore, for voltages of 751 volts to 72.5 kilovolts, the final rule adopts a 0.61-meter (2-foot) ergonomic-movement component of the minimum approach distance, as proposed.

As OSHA explained in the preamble to the proposed rule, the applicable work practices change for operations involving lines energized at voltages over 72.5 kilovolts (70 FR 34862; 269-Exs. 64, 65). Generally, live-line tools are employed to perform the work while equipment is energized. These tools hold the energized part at a fixed distance from the employee, ensuring that the minimum approach distance is maintained during the work operation. Even when live-line tools are not used, as during live-line barehand work, employees use work methods that more tightly control their movements than when they perform rubber glove work, and it is usually easier to plan how to keep employees from violating the minimum approach distance. For example, employees planning a job to replace spacers on a 500-kilovolt overhead power line can circumscribe an envelope (or bounds) of anticipated movement for the job and ensure that the working position they select keeps this envelope entirely outside the minimum approach distance. Thus, all the employees' movements during the job can easily be kept within the envelope. Additionally, there is limited or no exposure to conductors at a potential different from the one on which work is being performed because the distance between conductors is much greater than the distance between conductors at lower voltages and higher voltage systems do not present the types of congestion that are found commonly on lower voltage systems. Consequently, a smaller ergonomic component is appropriate for higher voltages. The NESC subcommittee developing the 1993 standard accepted a value of 0.31 meters (1 foot) for this component. This ergonomic component also remained the same in the 2007 NESC (Ex. 0533). OSHA used this value in existing § 1910.269 and proposed it in this rulemaking. There were no comments on this issue in this rulemaking, therefore, OSHA is adopting the proposed ergonomic-movement component of 0.31 meters (1 foot) for voltages over 72.5 kilovolts.[191]

EEI misconstrued OSHA's proposal as increasing the ergonomic-movement component in existing § 1910.269 by 0.61 meters (2 feet), for a total ergonomic component of 1.22 meters (4 feet) for voltages up to 72.5 kilovolts (Exs. 0227, 0392; Tr. 1056–1082). Testifying on behalf of EEI, Mr. Clayton Abernathy of OG&E Energy Corporation described how increasing the minimum approach distance by 0.61 meters would restrict some of the work performed by his company's employees (Tr. 1056–1082).

The ergonomic components of the minimum approach distances in OSHA's proposal were the same as the ergonomic components used for the minimum approach distances in existing § 1910.269 for voltages over 1,000 volts. The ergonomic component for voltages between 751 volts and 72.5 kilovolts (the voltages addressed by EEI's comments) is 0.61 meters. The ergonomic component of the proposed minimum approach distances for those voltages was not, contrary to EEI's suggestion, greater than that value. It appears that EEI's objections were aimed at two other proposed requirements: (1) Proposed § 1926.960(c)(2)(ii), which provided that, when using rubber insulating gloves or rubber insulating gloves with sleeves for insulation against energized parts, employees put on and take off their rubber insulating gloves and sleeves when they are in positions from which they cannot reach into the minimum approach distance, and (2) proposed § 1926.960(d)(2), which provided that employees performing work near exposed parts energized at 601 volts to 72.5 kilovolts either work from positions from which they cannot reach into the minimum approach distance or use specified protective measures or work methods. OSHA addresses EEI's concerns with these proposed provisions later in this section of the preamble.

Finally, OSHA addresses some confusion expressed by commenters during the rulemaking about whether

[188] This calculation is comparable to the calculation of total braking distance for a motor vehicle. This distance equals the initial speed of the vehicle times the driver's reaction time plus the stopping distance of the vehicle after the driver applies the brakes.

[189] At all voltages, the values for the ergonomic component of the minimum approach distance are the same in the 2012 NESC as they are in the 2007 NESC.

[190] EEI did, however, object to what it mistakenly believed was a proposed increase in the ergonomic component over what was adopted in existing § 1910.269 (Exs. 0227, 0501; Tr. 1056–1082). OSHA discusses these comments later in this section of the preamble.

[191] In the 1994 § 1910.269 rulemaking, OSHA adopted an ergonomic-movement factor based on English units of 1 foot or 2 feet, depending on voltage. It should be noted that, to three significant digits, 0.305 meters is 1.00 foot and 0.610 meters is 2.00 feet. In this final rule, OSHA used metric units and rounded 0.305 meters up to 0.31 meters.

the ergonomic component of the minimum approach distance should be used in determining whether a line worker is exposed to phase-to-phase or phase-to-ground voltage (Tr. 1060–1061, 1076–1077).

As noted earlier in this section of the preamble, under the summary and explanation for final § 1926.97(c)(2)(i) and Table E–4, the final rule permits insulating protective equipment to be rated for phase-to-ground voltage if "[t]he electric equipment and devices are insulated . . . so that the multiphase exposure on a grounded wye circuit is removed" (Table E–4, Note 1).[192] Existing § 1910.137 and Table I–5 contain the same provisions. OSHA policy with regard to whether there is multiphase exposure under existing § 1910.137 is discussed in a September 27, 2005, letter of interpretation to Mr. Edwin Hill, IBEW President.[193] This letter explains how to determine whether multiphase exposure exists:

> Phase-to-phase exposure exists whenever it is foreseeable that an employee or the longest conductive object he or she may handle can simultaneously breach the electrical components of the MADs of live parts energized at different phase potentials, taking into account such factors as: The nature of the work being performed, the physical configuration and spacing of the conductors, the proximity of grounded objects or other circuit conductors, the method of approach to the conductors, the size of the employee, the tools and equipment being used, and the length of the conductive object. In addition, the employer must always consider mechanical loads and other conditions, such as wind and ice, that could cause a conductor to move or a support to fail. Notably, the determination of whether or not multiphase exposure exists is made without regard to insulation that may be covering the live part or the employee. This is because the exposure determination must be made prior to the selection of insulation in order to ensure that the insulation selected is adequate to protect employees from the electrical hazard. Moreover, it must be noted that phase-to-phase exposure involves not only the hazard of electric shock to the employee, but also arc flash and arc blast hazards from phase-to-phase contact of conductive objects, such as could occur if an employee dropped a conductive object onto or within the electrical components of the MADs of live parts energized at different phase potentials. [Figures] illustrating when phase-to-phase exposure exists can be found at the conclusion of this letter. . . .

Figure 3 and Figure 4 are the figures from that letter:

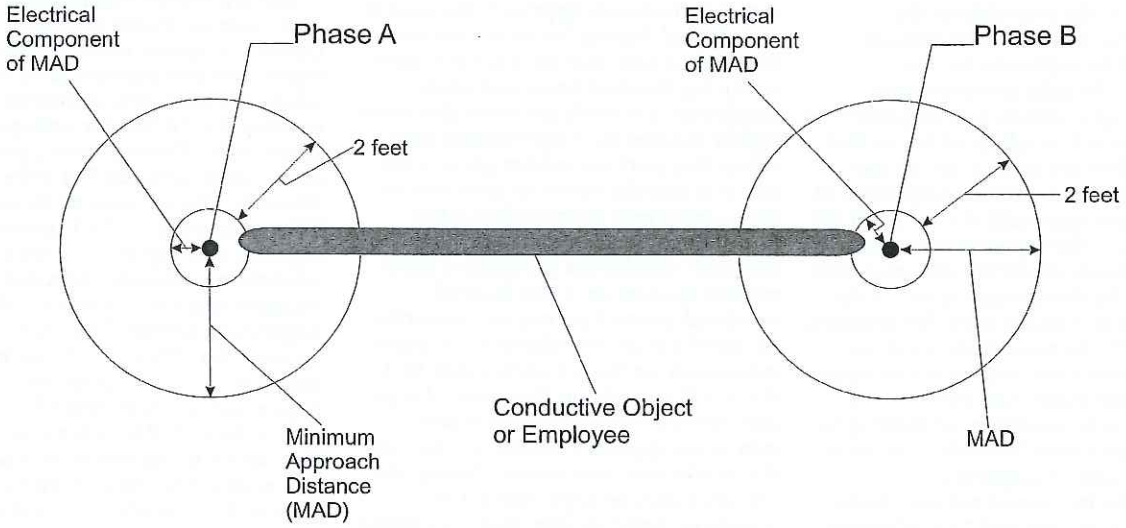

Figure 3—Phase-to-phase (Multiphase) Exposure

[192] Note that the word "exposure" in the note relates to the maximum voltage that can appear across the insulation, and not to whether an energized part is "exposed." The definition of "exposed" in final § 1926.968 applies only to the use of that term in Subpart V. It does not apply to final § 1926.97.

[193] This letter is available on OSHA's Web site at: *http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=25133.*

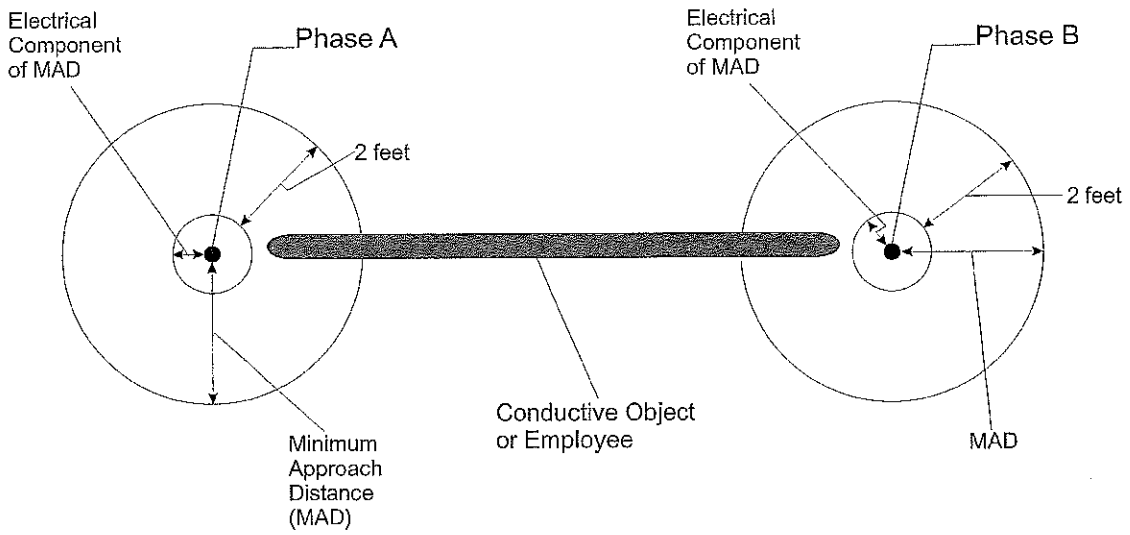

Figure 4—No Multiphase Exposure

The 0.61-meter ergonomic component of the minimum approach distance is labeled "2 feet" in these figures. As can be seen from the explanation and figures in the letter of interpretation, the ergonomic component of the minimum approach distance has no bearing on whether there is multiphase exposure. The rating required for the insulating protective equipment installed on the phase conductors depends on the electrical component of the minimum approach distance (which, in turn, depends on the voltage on the power line, as discussed later in this section of the preamble), the distance between the phase conductors, and the reach of the employee and any conductive object he or she may handle while working. As noted in the letter to Mr. Hill, when multiphase exposure exists, the insulating protective equipment used to remove multiphase exposure must be rated for the phase-to-phase voltage at a minimum.[194] In addition, the preamble to the 1994 § 1910.269 rulemaking noted that "until the multiphase exposure has actually been removed, the phase-to-phase voltage remains the maximum use voltage" (59 FR 4328). After the insulating protective equipment covering the conductors not being worked on is in place, the rubber insulating gloves and sleeves need only be rated for the phase-to-ground voltage. This is current OSHA policy under existing §§ 1910.137 and 1910.269 and will continue to be the policy of the Agency under this final rule.

The electrical component of MAD—general. The differences between the minimum approach distances under existing § 1910.269 and the minimum approach distances under this final rule are the result of changes in the way the Agency is calculating the electrical components of the minimum approach distances. As described previously, this final rule adopts the ergonomic components of the minimum approach distances used in existing § 1910.269. In addition, as explained later in this section of the preamble, the number of variables (such as elevation, maximum transient overvoltage, type of exposure, and type of insulating medium) involved in determining the appropriate minimum approach distance in any particular set of circumstances makes setting minimum approach distances exclusively by means of tables unmanageable. This approach would require one set of tables for each potential set of variables. Consequently, the final rule requires the employer to establish an appropriate minimum approach distance based on equations that OSHA is adopting in Table V–2. The final rule also contains a table, Table V–5, that specifies alternative minimum approach distances for work done at elevations not exceeding 900 meters (3,000 feet) for system voltages of 72.5 kilovolts and less. Finally, Appendix B to final subpart V contains tables of minimum approach distances, for varying maximum transient overvoltages for system voltages above 72.5 kilovolts, that employers may use for work done at elevations not exceeding 900 meters.

Some rulemaking participants questioned the need for any changes to the minimum approach distances in existing § 1910.269. (See, for example, Exs. 0227, 0545.1, 0551.1, 0552.1; Tr2. 71.) For instance, Mr. Charles Kelly with EEI testified:

> [U]nder Sections 3(8) and 6(b) of the Occupational Safety and Health Act, as long interpreted by the Supreme Court, OSHA [is] required to show that the change[s] in the clearance distances are, as a matter of substantial evidence, reasonably necessary to protect employees, and that they would reduce or eliminate a significant risk for employees.
>
> As several people have stated previous to our testimony, we are not aware that the existing MAD distances, even though they may have been mathematically incorrect for decades, have shown to be unsafe in that they have contributed to accidents or placed employees at substantial risk of harm. We doubt seriously that a desire to make a technical mathematical correction is enough to satisfy this requirement. [Tr2. 71–72]

IBEW also maintained that the minimum approach distances in existing § 1910.269 are adequate:

> It is important to look at how the use [of] MAD values, regardless of the origin and year of publication, have protected workers performing tasks in the vicinity of energized power lines. The IBEW regularly reviews accidents occurring in the electric utility industry. We cannot remember a single accident caused by inadequate MAD values. OSHA 1910.269 MAD values have proven to protect workers as they were intended to do. The obvious question then is why change successful MAD values? Based on industry performance, we do not see why changes are necessary. [Ex. 0551.1]

[194] It should be noted that the insulating values of two insulating materials in series are not additive (Exs. 0041, 0532; 269-Ex. 60). At least one layer of insulation must be rated for the maximum voltage for the exposure.

As OSHA explained in Section II.D, Significant Risk and Reduction in Risk, earlier in this preamble, the Agency need not make hazard-specific or provision-specific risk findings. In any event, the Agency concludes that the electric-shock hazards faced by employees performing electric power generation, transmission, and distribution work are serious and significant and that the changes to the minimum approach-distance provisions in this final rule are reasonably necessary and appropriate to reduce a significant risk to employees.

OSHA finds that employees are being injured by the dielectric failure of air (that is, sparkover) between them (or a conductive object they are handling) and conductive objects at a different potential. It is widely recognized that electric current can arc over distances and that it is necessary only to come too close to, rather than contact, an energized object to sustain an electric shock. In fact, some of the accidents in the record occurred when an employee brought a conductive object or himself or herself too close to an energized part and electric current arced to the object or employee (Exs. 0002,[195] 0003 [196]).

The Agency does not believe that it is necessary to show that the specific minimum approach distances in the existing standards have led to accidents. Instead, it is only necessary to show that the probability of sparkover at the worksite, given the existing minimum approach distances, is significant. The sparkover voltage between two objects at different potentials is recognized as following a normal distribution (Ex. 0532). The withstand voltage for an air gap between two objects at different potentials is three standard deviations below the statistical mean sparkover voltage. This represents approximately a 1 in 1,000 probability that the air gap will fail dielectrically and spark over.[197] The withstand distance is the distance between two objects corresponding to a given withstand voltage. (In other words, the withstand distance is the shortest distance between two objects that will spark over at a given voltage approximately one time in 1,000.) Consensus standards have based the electrical component of the minimum approach distance on the withstand distance corresponding to the maximum voltage that can occur at the worksite. (See, for example, Exs. 0076, 0077, 0532, 0533.) When the electrical component of the minimum approach distance is less than the withstand distance for the maximum voltage at the worksite, the probability of sparkover is greater than 1 in 1,000. OSHA, therefore, concludes that employees are at significant risk of injury whenever the electrical component of the minimum approach distance is less than the withstand distance for the maximum voltage that can occur at the worksite. As explained in detail later in this section of the preamble, several of the minimum approach distances contained in the existing OSHA standards and in the proposed rule represent a significant risk of injury under this criterion.

The electrical component of MAD—tools and conductive objects in the air gap. The methodology used to develop the proposed minimum approach distances, which were based on the 2002 NESC, did not account for tools in the air gap. As noted in the 2009 reopening notice, the presence of an insulated tool in the air gap reduces the air gap's dielectric strength (74 FR 46961). IEEE Std 516–2009 (Ex. 0532) generally provides two values for the electrical component of the minimum approach distance: One in air (called MAID [198]) and one with a tool in the air gap (called MTID [199]). However, that consensus standard does *not* provide minimum tool-insulation distances for either: (1) Any exposures (phase-to-ground or phase-to-phase) at voltages of 72.5 kilovolts or less or (2) phase-to-phase exposures at voltages of more than 72.5 kilovolts. In the 2009 reopening notice, the Agency requested comments on whether any of the minimum approach distances in the final rule should be based on minimum tool-insulation distances rather than minimum air-insulation distances. A similar question was raised in the 2008 reopening notice.

Scenario 1—exposures at 72.5 kilovolts and less. Rulemaking participants generally opposed basing minimum approach distances for voltages of 72.5 kilovolts and less on minimum tool distances. (See, for example, Exs. 0543.1, 0545.1, 0548.1, 0550.1; Tr2. 88.) For instance, Pike Electric commented, "Pike utilizes proper rubber protective cover-up at . . . voltages [of 72.5 kilovolts and lower]. This technique would eliminate the hazard of employee exposure to energized lines and equipment, so there is no need to utilize a MAD approach using tool insulation distances" (Ex. 0543.1). EEI and Southern Company argued that only one set of minimum approach distances is necessary for work on systems operating at voltages of 72.5 kilovolts and less because, based on IEEE Std 516–2009, minimum tool distances and minimum air distances are the same at those voltages (Exs. 0545.1, 0548.1). American Electric Power maintained that, for voltages at or less than 72.5 kilovolts, MAD has not been based on minimum tool distances in the past, so doing so now could potentially confuse workers (Ex. 0550.1).

IEEE Std 516–2009 defines MTID as "the required undisturbed air insulation distance that is needed to prevent a tool flashover at the worksite during a system event that results in the maximum anticipated TOV" (Ex. 0532). Although the specified minimum tool distances in IEEE Std 516–2009 are the same as the corresponding minimum air-insulation distances for voltages of 72.5 kilovolts and less, the consensus standard includes the following disclaimer in Section 4.5.2.1: "The MTID for ac and dc line-to-line voltages at and below 72.5 kV *has not been determined.* Industry practices normally use an MTID that is the same as or greater than the MAID" (*id.;* emphasis added). Thus, IEEE Std 516–2009 does not indicate that the minimum air- and tool-insulation distances are the same, nor does it contain tables with minimum tool-insulation distances for voltages of 72.5 kilovolts and less. According to IEEE Std 516–2009, electrical testing at higher voltages indicates that the dielectric strength of an air gap is lower when an insulating tool is present across the gap or when a conductive object is present within the gap (*id.*). OSHA concludes that minimum approach distances for voltages of 72.5 kilovolts and less should be conservative enough so that the gap will withstand the electric potential across it even if a tool bridges the gap or a conductive object is present within it. As explained later in this section of the preamble, the final rule specifies minimum approach distances that meet this criterion. Because the final rule does not adopt separate minimum approach distances for exposures with and without tools at 72.5 kilovolts and less, the concerns about confusion at these voltages are unfounded.

Scenario 2—phase-to-ground exposures at more than 72.5 kilovolts. Some commenters maintained that the final rule should follow the practice of

[195] See, for example, the five accidents described at *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=908012&id=170220602&id=564740&id=14496384&id=14418321.*

[196] See, for example, the three accidents described at *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=200000453&id=201350485&id=596304.*

[197] The probability of sparkover at the withstand voltage is 0.14 percent or 1.4 in 1,000.

[198] MAID is the minimum air-insulation distance.

[199] MTID is the minimum tool-insulation distance.

the 2007 NESC and base minimum approach distances for phase-to-ground exposures at voltages of 72.6 kilovolts and higher on the minimum tool distance. (See, for example, Exs. 0519, 0521, 0528, 0543.1.) For instance, Mr. Brian Erga with ESCI commented:

> The MAD for voltages above 72.6 kV should be based on the minimum tool distance as published in the 2007 NESC. Live line work is conducted with tools, workers and equipment within the electrical field of energized lines and equipment[,] and the minimum tool distance is correct information to be provided to the industry. [Ex. 0521]

Others suggested that the final rule include two sets of minimum approach distances for phase-to-ground exposures at voltages exceeding 72.5 kilovolts: One each for work performed with and without tools in the air gap. (See, for example, Exs. 0545.1, 0548.1, 0575.1; Tr2. 88.) For instance, Mr. Charles Shaw with Southern Company commented:

> In the proposed rule, OSHA is using minimum air insulation distances when a line worker is using a tool in the air gap. Allowing the minimum air insulation distance plus an inadvertent movement factor to be used as the live-line tool distance is an incorrect interpretation of the science behind the IEEE method. At a minimum, the note in the [Subpart] V and [§ 1910.269] tables that states that the referenced distances are for "live-line tool distances" should be removed since they are not.
>
> However, we recommend that OSHA include two sets of minimum approach distances for phase to ground work on voltages above 72.5 kV, one for work performed without tools in the air-gap and one for work performed with tools in the air gap. These distances should be based on MAID and MTID respectively using the method shown in IEEE 516–2009. [Ex. 0548.1]

Some commenters suggested that separate sets of air and tool minimum approach distances might be necessary for phase-to-ground exposures above 72.5 kilovolts because basing minimum approach distances solely on minimum tool distances could prevent employees from performing activities such as climbing and inspection with lines or equipment energized. (See, for example, Ex. 0549.1, 0573.1; Tr2. 54–55.)

EEI submitted evidence that approximately 23 percent of the insulators installed on transmission systems, and 25 percent of insulators installed on systems operating at 345 kilovolts and more, would be too short to accommodate the IEEE standard's minimum approach distances for tools (Ex. 0575.1). EEI noted that "there have been no reported safety events or flashovers with the current insulator lengths" [200] and maintained that using MAD for tools would force employers to perform routine inspections under deenergized conditions (*id.*).

Minimum approach distances in the 2007 NESC and IEEE Std 516–2009 are generally based on a substantial body of electrical tests run on air gaps with and without objects in them (Ex. 0532; Tr2. 38).[201] A 1968 IEEE Committee Report entitled "Recommendations for Safety in Live Line Maintenance," and a 1973 IEEE Committee Report entitled "Live-Line Maintenance Methods," presented a formula, based on that testing, for calculating minimum safe distances for energized power line work (Exs. 0556, 0558). This formula, which is given later in this section of the preamble, generally provides for a 10-percent increase in distance to account for the presence of tools across the air gap. [202]

IEEE Std 516–2009, in Section 4.7.9.2, recognizes the effect that a large floating object has on minimum approach distances:

> When a large floating object, not at ground or the conductor potential, is in the air gap, additional compensation may be needed to provide for the size and location of the floating object in the air gap. [Ex. 0532]

IEEE Std 516–2009 accounts for this effect by reducing the withstand voltage by 10 percent for phase-to-phase exposures on systems operating at more than 72.5 kilovolts (*id.*). This approach effectively increases the minimum approach distance by at least 10 percent. Although IEEE Std 516–2009 applies a floating-object correction factor only to phase-to-phase exposures, the effect (as noted in the quoted passage) also applies to phase-to-ground exposures.

In light of the comments received and the other information in the record, OSHA concludes that, for phase-to-ground exposures at voltages of more than 72.5 kilovolts, basing minimum approach distances on minimum air-insulation distances will not provide sufficient protection for employees when insulated tools or large conductive objects are in the air gap. Minimum air-insulation distances are based on testing air gaps with only air between the electrodes, which does not account adequately for the presence of tools (Ex. 0532). Therefore, the provisions adopted in the final rule ensure that minimum air-insulation distances are applied only when air alone serves as the insulating medium protecting the worker. For phase-to-ground exposures at voltages of more than 72.5 kilovolts, Table V–2 requires employers to establish minimum approach distances that are based on the minimum air-insulation distance "for phase-to-ground exposures that the employer can demonstrate consist only of air across the approach distance." Otherwise, the minimum approach distances for these exposures must be based on the minimum tool-insulation distance.

Scenario 3—phase-to-phase exposures at more than 72.5 kilovolts. The third and final scenario the Agency has to address is the presence of tools or other insulation across a phase-to-phase air gap at voltages of more than 72.5 kilovolts. Rulemaking participants maintained that, for voltages of more than 72.5 kilovolts, minimum approach distances based on minimum tool-insulation distances are unnecessary because the phase-to-phase air gap is rarely, if ever, bridged by an insulated tool. (See, for example, Exs. 0545.1, 0548.1, 0550.1, 0551.1; Tr2. 89, 157). For instance, Dr. Randy Horton, testifying on behalf of EEI, stated:

> [EEI is] unaware of any live-line working scenario situations above 72.5 kV where the phase-to-phase air gap is bridged by live-line tool. Most work practices are developed to work on only one phase at a time per structure, phase to ground. [Tr2. 89]

Thus, the rulemaking record indicates that, for voltages over 72.5 kilovolts, tools or other objects infrequently, if ever, bridge the gap between two phases. Considering how rare the practice of spanning the air gap is, OSHA decided against adopting generally applicable minimum approach distances that account for tools in the gap for phase-to-phase exposures at these voltages. However, there is still a need to account for conductive bodies in the air gap in the limited circumstances in which they are present, for example, when an employee is moving between phases in an aerial lift. Therefore, OSHA is including provisions in the final rule ensuring that the phase-to-phase minimum approach distance for voltages over 72.5 kilovolts takes account of any objects that will be present in the air gap. Table V–2 requires the employer to establish minimum approach distances that are based on the minimum air-insulation distance as long as "the employer can demonstrate that no insulated tool spans

[200] OSHA is unsure what EEI meant by "safety event," but assumes that it means accident or near miss.

[201] As noted later in this section of the preamble, the 2012 NESC distances are identical to corresponding minimum approach distances in IEEE Std 516–2009.

[202] The equation included a factor, C_2, equal to "1.1, composed of 1.06 for live-line tool-to-air withstand distance ratio plus intangibles" (Ex. 0556).

the gap and that no large conductive object is in the gap."[203]

The electrical component of MAD—maximum transient overvoltages. Existing § 1910.269 and OSHA's 2005 proposal specified maximum transient overvoltages of 3.0 per unit for voltages up to 362 kilovolts, 2.4 per unit for voltages in the 550-kilovolt range (500 to 550 kilovolts, nominal[204]), and 2.0 per unit for voltages in the 800-kilovolt range (765 to 800 kilovolts, nominal). These are known as "industry-accepted values" of maximum per-unit overvoltage (Ex. 0532). The IEEE committee and the electric utility industry, as evidenced by the 1993 through 2002 NESC and pre-2003 editions of IEEE Std 516, believed that these were the highest transient overvoltages possible. However, the 2007 NESC and IEEE Std 516–2009 recognize that even higher maximum per-unit transient overvoltages can exist (Exs. 0532, 0533).[205] Therefore, OSHA requested comments on how, if at all, the final rule should address the possibility of higher maximum transient overvoltages.

No rulemaking participants disputed that overvoltages beyond those accounted for in the proposed standard were possible. Pike Electric recommended that minimum approach distances be calculated for the highest possible transient overvoltage (Ex. 0543.1). IBEW suggested that, if the higher per-unit overvoltage factors are included, specific instructions for using those higher factors also should be included in the final rule (Ex. 0551.1; Tr2. 158).

Electric utility representatives argued that, even though higher overvoltages are possible, their industry does not widely recognize that higher overvoltages exist. (See, for example, Exs. 0545.1, 0548.1, 0549.1, 0550.1; Tr2. 90–93.) These rulemaking participants urged OSHA to base the final standard on the existing industry-accepted values upon which the proposal was based (*id.*). For example, Southern Company stated, "Although IEEE 516–2003 and IEEE 516–2009 recognize the possibility of higher surge values, the concept that such surges exist is not widely accepted in the Industry" (Ex. 0548.1).

Dr. Randy Horton, testifying on behalf of EEI, explained this position as follows:

> Over the years, none of the field-measured over-voltages on actual operating systems has produced results which exceed the industry accepted *T* values (transient overvoltage values). The documentation of these measurements and of numerous simulations, encompassing all current transmission operating voltages, and the results have consistently supported the accepted *T* values. [Tr2. 90]

However, Dr. Horton acknowledged that one utility (Bonneville Power Administration, or BPA) measured overvoltages above 3.0 per unit on one of its 230-kilovolt circuits (*id.*). As he noted, BPA tested that circuit in response to sparkovers on rod gaps placed on the circuit to protect it from lightning strikes (Tr2. 90–91). Dr. Horton argued that the measured overvoltages on that circuit were unrealistic because: (1) The gaps on the circuit flashed over at overvoltages less than 3.0 per unit during testing; (2) the circuit breaker characteristics and performance, including pole-closing spans and breaker current, were unrealistic; and (3) monitoring inaccuracies could have occurred, leading to measurements that were too high. (See, for example, Exs. 0546.1, 0575.1; Tr2. 90–92.) EEI recommended adhering to the industry-accepted overvoltage values. However, it noted that, if OSHA elected to account for the values of maximum per-unit overvoltage from the BPA measurements, the final rule should just include a footnote similar to that contained in IEEE Std 516–2009, noting: "At 242 kV, it is assumed that automatic instantaneous reclosing is disabled. If not, the values shown in the table may not be valid, and an engineering evaluation should be performed to determine '*T*'" (Ex. 0545.1; Tr2. 93).

In its posthearing submission, EEI offered evidence suggesting that the industry-accepted values of maximum per-unit transient overvoltage are reasonable (Ex. 0575.1). In this submission, EEI reported results of testing on several other systems of varying voltages, none of which exceeded the industry-accepted values. EEI explained:

> The field tests were conducted for energization, reclosings and with or without shunt reactors. Attempts were made to obtain the worst possible overvoltages during the field tests. For all cases, listed above, the expected overvoltages, now, would be lower since the system has matured and at each bus, the source strength has increased considerably. . . .
>
> The IEEE Transactions Papers on the aforementioned information are provided below. Additional IEEE Transactions Papers references are attached for switching overvoltage field tests on system voltage levels of 220 kV, 345 kV and 500 kV by various power companies, including American Electric Power. All papers show that:
>
> • Without breaker closing resistors, the maximum switching overvoltages do not exceed 3.0 pu.
>
> • With closing resistor, the maximum switching overvoltages are near 2.0 pu. And, with control closings the maximum switching overvoltages do not exceed 1.6 pu.
>
> • Calculated overvoltages are generally much higher than those by the field measured values . . . [*Id.*]

EEI also pointed to an excerpt from International Electrotechnical Commission (IEC) Standard 61472 as evidence that higher maximum transient overvoltages are possible, but unlikely (*id.*). This IEC excerpt reads as follows:

> B.2.2 Overvoltages under abnormal conditions.
>
> Among the possible abnormal conditions which can lead to very high overvoltages, restrikes between the contacts of circuit breakers during opening is considered, and in particular the following conditions may be of concern:
>
> –single or three-phase opening of no load lines;
>
> –three-phase clearing of line-to-earth fault.
>
> Such abnormal behaviour may lead to overvoltage amplitudes of the same order or even higher than those under three-phase reclosing.
>
> However, the restrike probability of circuit breakers is normally low, and is very low for the modern circuit breaker. So the low probability of these events is not such as to influence the probability distribution of the family considered (opening or fault clearing) and thus the relevant U_{e2} value. [*Id.*]

OSHA understands that the information in the record pertaining to maximum transient overvoltages applies basically to voltages over 72.5 kilovolts.

[203] Two variables in the equation for minimum approach distances account for tools or large conductive bodies in the air gap. The variable *C* is 0.01 for exposures that the employer can demonstrate are with air only between the employee and the energized part if the employee is at ground potential or between the employee and ground if the employee is at the potential of the energized part, or 0.011 otherwise. Because it is rare that tools or large conductive bodies are in the air gap between phases, employers should not have difficulty making this demonstration for phase-to-phase exposures. The second variable, the saturation factor, *a*, is calculated differently when an insulated tool spans the gap or a large conductive object is in the gap. For phase-to-phase exposures, the final rule requires this factor generally to be based on air only in the gap.

[204] Table R–7 and Table R–8 in existing § 1910.269 and Table V–1 and Table V–2 in existing subpart V list the upper bound of this voltage range as 552 kilovolts. Table R–6 in existing § 1910.269 lists the upper bound of this voltage range as 550 kilovolts, which is the correct value (Ex. 0532). The final rule uses 550 kilovolts as the upper bound of this voltage range.

[205] Table 441–2 of the 2007 NESC contains minimum approach distances with maximum transient overvoltages higher than the industry-accepted values, though the higher values do not apply when certain conditions are met (Ex. 0533). Section 4.7.4.3 of IEEE Std 516–2009 lists the industry-accepted values for maximum transient overvoltages. However, it also states that, if certain assumptions about the operation of the system are not met, "the values listed in the table may not be valid, and an engineering evaluation should be performed to determine [the maximum per-unit transient overvoltage]" (Ex. 0532).

IEEE Std 516–2009 does not include separate overvoltage factors for voltages of 72.5 kilovolts and less (Ex. 0532). For voltages of 72.5 kilovolts and less, IEEE Std 516–2009 relies on a maximum transient overvoltage of 3.0 per unit and does not recognize the possibility of higher values. Section 4.8.1d of IEEE Std 516–2009 states, "Shunt-connected devices, such as transformers, and reactors will tend to reduce the trapped charge on the line and, therefore, limit the overvoltages due to reenergization" (*id.*). Such shunt-connected devices are not only pervasive on systems of 72.5 kilovolts and less, but are a necessary part of the distribution systems that form the overwhelmingly predominant portion of these systems (see, for example, 269-Ex. 8–13). Even for the 45- and 69-kilovolt systems that are sometimes used in transmission circuits, there is no evidence in the record that maximum transient overvoltages exceed 3.0 per unit. Consequently, the final rule adheres to a maximum transient overvoltage of 3.0 per unit for systems with a nominal phase-to-phase voltage of 72.5 kilovolts or less. OSHA calculated the values in Table V–3, which are the electrical components of the minimum approach distances, using a maximum transient overvoltage of 3.0 per unit.

For voltages of more than 72.5 kilovolts, no rulemaking participant disputed the fact that maximum transient overvoltages based on engineering calculations can exceed those on which the proposed rule was based. (See, for example, Exs. 0532, 0575.1.) It also is clear that maximum transient overvoltages exceeding industry-accepted values are possible as IEEE Std 516–2009, IEC Standard 61472, and the BPA report show. (*id.*) The evidence in the record indicates that most systems do not, however, exceed the industry-accepted values on which the proposal was based. (See, for example, Exs. 0545.1, 0549.1, 0575.1; Tr2. 90–93.) This is the major argument relied on by the commenters that urged OSHA to base the final rule on industry-accepted values of maximum transient overvoltage (*id.*).

The Agency considered all of the comments and record evidence on this issue and concluded that the arguments against relying on BPA's report are not strong enough to justify ignoring it for purposes of this final rule. First, EEI argued that, in the BPA scenario, during testing the gaps on the circuit flashed over at overvoltages *less* than 3.0 per unit (see, for example, Tr2. 91). The magnitude of the overvoltage during these gap sparkovers is irrelevant. In one series of tests, the measured overvoltages for two of the tests in which three gaps arced over were lass than 3.0 per unit. However, measured overvoltages on at least one phase exceeded 3.0 per unit during 10 of the tests, including both tests involving sparkovers.[206] For this circuit, the testing found overvoltages as high as 3.3 per unit. The BPA report explained:

> Rod gap flashovers occurred . . . during the last two tests of [one test series]. . . . [S]ignificantly higher overvoltages were measured on [the] phases [with flashovers] during other tests in the series, but the gaps did not flash over. This demonstrates the highly statistical nature of . . . gap flashover . . . . [Ex. 0575.1]

Thus, that the measured overvoltages for the sparkovers were less than 3.0 per unit has no bearing on whether overvoltages exceeding 3.0 per unit are possible.

Second, EEI's argument that the circuit breaker characteristics were unrealistic are unpersuasive. EEI argued that, because "[t]he field tests were conducted with individual phase breaker pole control," the pole-closing span[207] was exceedingly large and unrealistic (*id.*). Although BPA controlled the opening and closing of the circuit breakers during testing to "measure overvoltage levels that can occur on a long transmission line during high speed reclosing," there is no indication in the BPA report that it varied the closing spans for the individual poles on the circuit breakers (*id.*). The report states:

> [The relevant test series] involved three-phase reclosing into trapped charge on the Big Eddy-Chemewa 230-kV line. Breaker opening was controlled and synchronized to generate the same polarity and magnitude trapped charge on each phase for each test shot. Testing began by switching from the Big Eddy end, varying the closing time of the breaker uniformly over a complete 60 Hz cycle by increments of 18 electrical degrees (1/20 cycle). After these 20 tests, 4 additional tests were performed in an attempt to generate a maximum possible overvoltage. This same procedure was then repeated from the Chemewa end of the line. [*Id.*]

Thus, it appears that BPA took measures to synchronize the switching of the poles in each circuit breaker. The report mentioned that the circuit breaker at the Big Eddy end was "constructed with each phase in its own tank" (*id.*). The pole-closing span for this circuit breaker was 3.7 milliseconds. The circuit breaker at Chemewa was "constructed with all three contacts in a single tank" (*id.*). The pole-closing span for this circuit breaker was 0.24 milliseconds, significantly shorter than the pole-closing span for the Big Eddy circuit breaker. Measured overvoltages exceeded 3.0 per unit during tests with switching performed at both locations. Thus, OSHA concludes that pole-closing spans did not contribute to measured overvoltages exceeding 3.0 per unit during BPA testing. BPA did not indicate that the pole-closing span for either circuit breaker was unusual, and EEI did not submit any evidence that would demonstrate that circuit breakers of any type of construction generally have shorter pole-closing spans. Consequently, the Agency concludes that, even if the pole-closing span did contribute to the measured overvoltages in BPA's testing, circuit breakers in other installations could have similarly long pole-closing spans with correspondingly high maximum transient overvoltages.

Furthermore, although the difference in time taken for each pole to close might affect the phase-to-phase overvoltage, that value was not measured during the BPA tests. Because pole-closing spans only affect the offset between phases and should have no substantial effect on the behavior of the transient voltage on a single phase, long pole-closing spans should have little effect on phase-to-ground overvoltages (that is, the overvoltage on a single phase). As explained later, the report clearly states that the main cause of the unexpectedly high maximum transient overvoltages was "prestrike." OSHA, therefore, concludes that prestrike, not pole-closing spans, were the primary cause of the high maximum transient overvoltages.

EEI, through Dr. Horton, also expressed concern about the performance of the circuit breakers in the BPA report, because the circuit breaker current showed evidence of prestrikes (Tr2. 91). Restrike and prestrike may occur during the opening of circuit breakers. The current and voltage across the contacts of a circuit breaker vary with time. When the contacts are closed, the voltage across them is very close to zero, and the current oscillates at 60 cycles per second. When the contacts are open, the voltage oscillates, and the current is zero. As the contacts of a circuit breaker open or close, current can arc across them. When the current drops to zero,

[206] The measured overvoltages on the phases with gap sparkovers were under 3.0 per unit, but the measured overvoltages on the phases without gap sparkovers during the same tests exceeded 3.0 per unit. For example, during test 5–25, the overvoltage on the phase with the gap sparkover was 2.83 per unit, and the overvoltage on one of the other two phases was 3.30 per unit.

[207] The circuit-breaker pole-closing span is the maximum closing time difference between the phases.

the arcing stops. However, if the voltage across the contacts from reflected traveling waves exceeds the dielectric strength of the gap between the contacts, arcing can recur. Arcing that occurs after the initial arc is extinguished as the circuit breaker is opening is called "restrike." Arcing that occurs as the contacts close, but before they are touching, is called "prestrike."

Whether a circuit breaker is subject to restrikes or prestrikes is dependent on the design of the circuit breaker, maintenance of the circuit breaker, and the characteristics of the circuit to which the breaker is connected. Prestrikes and restrikes can lead to high transient overvoltages that can damage equipment. Therefore, manufacturers design circuit breakers to resist restrikes and prestrikes. However, the probability that these events will occur can be affected by maintenance and circuit design. Poor circuit breaker maintenance can lead to longer pole-opening times and can increase the probability that prestrike or restrike will occur. Similarly, circuit designs can shorten the time in which traveling waves reach the breaker contacts, which also can increase the probability of prestrikes or restrikes.

The circuit breakers that were the subject of BPA's testing exhibited prestrikes during testing (Ex. 0575.1). Commenting on this, Dr. Horton stated:

> The line breaker performance appears suspicious. The breaker current shows prestrikes with abrupt interruptions and subsequent re-ignitions [Tr2. 91]

However, the BPA report explained why the prestrikes occurred:

> During Test Series V, it was found that the sending end can experience significant overvoltages that were previously assumed to occur only out on the line or at the receiving end. During breaker prestrike, a current wave (initiated by arcing across the contacts) travels down the line to the receiving (open) end where it is reflected. As the reflected wave travels back toward the sending end of the line, it reduces the current to near zero along the line. When the reflected current wave reaches the sending end of the line, it creates a current zero and allows the prestrike arc between the breaker contacts to extinguish, isolating the line voltage from the bus voltage. After the arc extinguishes, the line voltage often increases due to traveling voltage waves that continue to be reflected from the receiving end. The voltage across the breaker then builds up until another prestrike occurs. The next prestrike occurs at a lower breaker cross voltage because the breaker contacts are closer together. In Test Series V, the majority of breaker closings resulted in only a single prestrike. However, in a few tests, up to four prestrikes occurred on one phase during a single closing operation. [Ex. 0575.1]

BPA found this information useful, explaining:

> This field test has also provided a considerable amount of data on 230-kV SF_6 breaker prestrikes. Typical characteristics of the dielectric strength across the breaker contacts have now been developed and can be used for statistical switching surge studies. Additional information has also been obtained about another property of 230-kV SF_6 breakers—where the prestrike arc is extinguished by the traveling current wave during line switching. The test results show that when the prestrike arc extinguishes, the voltage at the sending end of a line reaches values that are much higher than were previously expected. [*Id.*]

In light of this explanation in the BPA report itself, OSHA concludes that the existence of prestrikes does not invalidate the BPA report's findings. In fact, the prestrikes were the cause of the unexpectedly high maximum transient overvoltages. The Agency anticipates that any workplace where prestrikes occur during switching operations, particularly during reclosing, can experience similarly high maximum transient overvoltages.

EEI's third and final concern about the BPA report was that "inaccuracies in the monitoring system and in the waveform calibration [could have resulted] in unrealistic over-voltage readings" (Tr2. 91). However, there is no evidence in either BPA's report or in OSHA's rulemaking record that such inaccuracies existed during the BPA tests.

For the foregoing reasons, OSHA does not accept EEI's criticism of the BPA report and finds that it provides substantial evidence of the existence of maximum transient overvoltages higher than industry-accepted values.

IEEE Std 516–2009 does not account for the possibility of circuit-breaker restrikes. In Section 4.7.4.3, IEEE Std 516–2009 explains its approach for addressing maximum transient overvoltages, as follows:

> (a) At all voltage levels, it is assumed that circuit breakers are being used to switch the subject line while live work is being performed. This further assumes that the restrike probability of a circuit breaker is low and consequently extremely low while a worker is near the MAD and that it can, therefore, be ignored in the calculation of *T*. If devices other than circuit breakers are being utilized to switch the subject line while live work is being performed, then the values listed in the table may not be valid, and an engineering evaluation should be performed to determine *T*.
>
> (b) At 242 kV, it is assumed that automatic instantaneous reclosing is disabled. If not, the values shown in the table may not be valid, and an engineering evaluation should be performed to determine *T*. [Ex. 0532]

OSHA has serious concerns about the validity of the assumptions on which this IEEE standard relies to support its general application of the industry-accepted values for maximum transient overvoltages. Indeed, with all the caveats in these paragraphs of the IEEE standard, it is clear that even the drafters of that standard did not believe in the universal applicability of its key assumptions. IEEE Std 516–2009 recognizes that switching can be performed using devices other than circuit breakers and recommends an engineering analysis if such devices are used. The Agency concludes that the prestrike experience reported by BPA demonstrates that the occurrence of prestrikes is likely to be a consequence of the design of the circuit breaker and the circuit involved, rather than a low probability event for each circuit breaker on every circuit. The BPA report explained that the occurrence of prestrikes was influenced heavily by the magnitude of the trapped charge on the line and the speed of the initial and repeated reflected traveling wavefronts (Ex. 0575.1). Because the cause of prestrikes and restrikes are the same, the Agency believes that restrikes are similarly influenced. In this regard, prestrikes and restrikes are the same type of event, with prestrikes occurring during circuit breaker opening and restrikes occurring during circuit breaker closing. Thus, although the overall probability that circuit breakers in general will restrike or prestrike may be low, OSHA concludes that the probability that a particular circuit breaker will restrike or prestrike may be high enough that it cannot be ignored.

Additionally, neither the IEEE standard nor Dr. Horton explained why the IEEE committee chose to base maximum transient overvoltage on the 2-percent statistical switching overvoltage expected at the worksite, which is a probability-based assessment, while ignoring the probability of restrikes (Ex. 0532).[208] After all, if the probability is low enough, then the potential for restrikes will not have a significant effect on the 2-percent statistical switching overvoltage. On the other hand, if it is high enough, then the 2-percent statistical switching overvoltage will increase.

In response to EEI's recommendation to permit employers to use industry-accepted values in accordance with IEEE Std 516–2009, OSHA concludes

[208] Section 4.7.4.2 of IEEE Std 516–2009 reads, in part, "The line-to-ground maximum anticipated per-unit TOV (*T*) for live work is defined as the ratio of the 2% statistical switching overvoltage expected at the worksite to the nominal peak line-to-ground voltage of the system."

that this alternative does not adequately account for higher maximum transient overvoltages. Section 4.7.4.3b of IEEE Std 516–2009 indicates that the industry-accepted values are valid only when reclosing is blocked at 242 kilovolts (Ex 0532). Although the BPA testing was performed on a 242-kilovolt circuit, there is no evidence in the record indicating that maximum transient overvoltages higher than the industry-accepted values are limited only to this voltage. In addition, the IEEE standard, in Section E.2 of Appendix E, notes:

> If restriking of the switching device is included [in the determination of maximum transient overvoltage], then the resulting overvoltages are essentially the same as those of reclosing into a trapped charge. The only difference is the probability of occurrence. [*Id.*]

Consequently, even if reclosing is blocked, the maximum transient overvoltage may still exceed industry-accepted values.

OSHA concludes that it is not in the interest of worker safety to adopt minimum approach-distance provisions based on the conditions expected to be present in the workplaces of most, but not all, employers covered by this final rule. Basing the rule on industry-accepted values of maximum transient overvoltage, as EEI and other commenters recommended, would result in some employees not receiving adequate protection. In the extreme case, in which the maximum transient overvoltage is 3.5 instead of the industry-accepted value of 3.0, the electrical component of the minimum approach distance would sparkover nearly 50 percent of the time, rather than 0.1 percent of the time, at the maximum overvoltage. OSHA designed the minimum approach-distance provisions in this final rule to protect employees from the conditions that are present in their specific workplaces. Under the final rule, employers must select and adhere to minimum approach distances based on the maximum transient overvoltages present at their workplaces or base minimum approach distances on the highest maximum transient overvoltage.

EEI and other commenters noted that IEEE recently established a working group to examine maximum transient overvoltages and recommended that OSHA rely on industry-accepted values for these overvoltages until the committee reports its findings. (See, for example, Exs. 0545.1, 0548.1; Tr2. 92–93.) For instance, Dr. Horton, testifying on behalf of EEI, stated:

> In order to address the possibility of higher surge values, the General Systems Subcommittee of the IEEE Transmission and Distribution Committee has recently created a working group entitled "Field Measured Over-Voltages and Their Analysis" to determine if higher surge values actually exist, and if so, what is their upper limits. This working group is chaired by myself (Dr. Randy Horton of Southern Company) and is co-chaired by Dr. Albert Keri of American Electric Power. Numerous experts and utilities from around the world are involved in this work, and initial findings of the working group will likely be available in the next 3 to 4 years. Until such time, it is recommended that the industry accepted values (in other words *T* equal to 3 per unit, 2.4 per unit, and 2.0 per unit, corresponding to 362 kV and below, 363 kV to 550 kV, and 551 kV to 800 kV respectively) be used as the maximum per unit transient over-voltage values. [Tr2. 92–93]

The Agency concludes that it is not necessary to wait for the findings of the new IEEE working group before proceeding with new minimum approach-distance provisions. The Agency does not believe that it is necessary to delay action on minimum approach distances until the IEEE or any other standard-setting organization produces additional information on this subject. OSHA believes that there is sufficient information in the record, described earlier in this discussion of maximum transient overvoltages, to form the basis of a final rule on minimum approach distances that accurately accounts for the presence, magnitude, and effect of maximum transient overvoltages. The Agency concludes that BPA's experience proves the existence of maximum transient overvoltages higher than the industry-accepted values; and, although the consensus standards do not fully account for potentially higher values in their minimum approach distances, the 2007 NESC and the 2003 and 2009 editions of IEEE Std 516 recognize the existence of such overvoltages (Exs. 0041, 0532, 0533, 0575.1). Consequently, for purposes of Table V–6, and Table 7 through Table 14 in Appendix B to subpart V, the Agency is adopting maximum per-unit transient overvoltages of 3.5 for systems operating at 72.6 to 420 kilovolts, 3.0 for systems operating at 420.1 to 550.0 kilovolts, and 2.5 for systems operating at 550.1 to 800 kilovolts. These values are the same values as the highest maximum transient overvoltages recognized in the 2007 NESC and IEEE Std 516–2009 (Exs. 0532, 0533).

The electrical component of MAD—calculation methods for voltages up to 72.5 kilovolts. OSHA based the minimum approach distances in existing § 1910.269 for voltages up to 72.5 kilovolts on ANSI/IEEE Std 4 (59 FR 4383). Existing § 1910.269 specifies "avoid contact" as the minimum approach distance for voltages between 51 and 1,000 volts. To make the revised standards consistent with the 2002 NESC, OSHA proposed in the 2005 proposal to adopt minimum approach distances of 0.31 meters (1 foot) for voltages between 301 volts and 750 volts and 0.65 meters (2 feet, 2 inches) for voltages between 751 volts and 15 kilovolts. The proposal specified "avoid contact" as the minimum approach distance for 51 to 300 volts.

Two commenters objected to the requirement for employees to "avoid contact" with lines energized at 50 to 300 volts (Exs. 0169, 0171). Mr. Brooke Stauffer with NECA commented, "The 'avoid contact' requirement on lines energized at 50 to 300 volts is infeasible for line construction and maintenance, because linemen must contact these energized lines on a routine basis while doing their work" (Ex. 0171). Quanta Services similarly asserted, "The 'avoid contact' requirement on lines energized at 50 to 300 volts presents a problem because linemen will contact those lines on a routine basis while doing their work" (Ex. 0169).

These comments do not indicate how employees are contacting electric conductors and other circuit parts energized up to 300 volts.[209] It is well recognized that these voltages are potentially lethal. Exhibit 0002 alone describes at least 25 accidents in which employees were killed because of contact with circuit parts energized at 120 volts to ground.[210] OSHA believes that, in the past, the practice was for power line workers to use leather gloves rather than rubber insulating gloves to handle these voltages, and it is possible that these commenters are recommending that the standard permit that practice. However, leather gloves do not insulate workers from energized parts (Ex. 0002).[211] Perspiration can saturate these gloves during use, making them conductive. One of the accidents in the record involved an employee handling a 120-volt conductor with leather gloves (*id.*). Therefore, the final rule requires employees to avoid contact with circuit parts energized at 50 to 300 volts.[212] If it is necessary for employees to handle exposed parts energized at these voltages, they must do so in accordance with final § 1926.960(c)(1)(iii)(A), (c)(1)(iii)(B), or (c)(1)(iii)(C); and any insulating equipment used must meet the electrical protective equipment requirements in final § 1926.97.

There were few comments on the minimum approach distances proposed in 2005 for voltages of 301 volts to 72.5 kilovolts. Some commenters objected to the small changes in minimum approach distances from existing § 1910.269 that were specified in the 2005 proposal. (See, for example, Exs. 0227, 0543.1.) EEI maintained that the safety benefit of slight changes was outweighed by the practical implications of implementing revised minimum approach distances:

> For the sake of an inch or two, OSHA ought not to change the existing MAD tables. Such changes could require revising every safety rule book and training curriculum in the industry, including among line contractors, as well as related retraining of line workers. The established clearance distances are well-known to employees in the transmission and distribution industry, and changing them for the sake of an additional inch or two can only lead to confusion, with no significant safety benefit. As a practical matter, it is not clear that such a small change will make a significant difference in the safety of line workers. [Ex. 0227]

OSHA understands that changing minimum approach distances, even slightly, may require employers to adjust their safety rules and training. The Agency accounted for the cost of changing these safety rules and training because of differences between existing § 1910.269 and the final rule, including the revised minimum approach distances (see Section VI, Final Economic Analysis and Regulatory Flexibility Analysis, later in this preamble).

Ignoring evidence that small increases in the electrical component of the minimum approach distances are necessary would result in shrinking the ergonomic component of the minimum approach distance, thereby making work less safe for employees than if the ergonomic component remained constant. As explained previously, OSHA designed this final rule to ensure that the ergonomic component of the minimum approach distance remains at least 0.31 meters (1 foot) or 0.61 meters (2 feet), depending on the voltage.

OSHA proposed a minimum approach distance of 0.31 meters (1 foot) for voltages of 301 through 750 volts. Although there were no comments on this minimum approach distance, the Agency is adopting a slightly larger distance. In Section 4.7.1.1, IEEE Std 516–2009 explained its approach to setting the electrical component of the minimum approach distance, as follows:

> For ac and dc line-to-line and line-to-ground work between 300 V and 5.0 kV, sufficient test data are not available to calculate the MAID,[213] which is less than 2 cm or 0.07 ft. For this voltage range, it is assumed that MAID is 0.02 m or 0.07 ft . . . . [Ex. 0532]

Using this approach for voltages of 301 to 750 volts, OSHA added the 0.31-meter (1-foot) ergonomic component of the minimum approach distance to the 0.02-meter (0.07-foot) electrical component, for a total minimum approach distance of 0.33 meters (1.07 feet) in the final rule.

As noted earlier, OSHA based the methodology for calculating the electrical component of the minimum approach distance for voltages from 751 volts to 72.5 kilovolts in the 2005 proposal on IEEE Std 4. Table 6 lists the critical sparkover distances from that standard as listed in IEEE Std 516–2009.

TABLE 6—SPARKOVER DISTANCE FOR ROD-TO-ROD GAP

60 Hz Rod-to-rod sparkover (kV peak)	Gap spacing from IEEE Std 4–1995 (cm)
25	2
36	3
46	4
53	5
60	6
70	8
79	10
86	12
95	14
104	16
112	18
120	20
143	25
167	30
192	35
218	40
243	45
270	50
322	60

Source: IEEE Std 516–2009 (Ex. 0532).

To use the table to determine the electrical component of the minimum approach distance, the employer would 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. For voltages between 5 and 72.5 kilovolts, the process for using Table 6 to calculate the electrical component of the minimum approach distance, starting with the phase-to-phase system voltage, was described generally as follows in Draft 9 of the 2009 revision to IEEE Std 516 (Ex. 0524):

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 earlier in this section of the preamble. This is the maximum phase-to-ground transient overvoltage, which corresponds to the withstand voltage for the relevant exposure.[214]

[209] In the proposed rule, the lowest voltage in the avoid-contact range was 51 volts, not 50 volts as indicated by the two commenters.

[210] See the 25 accidents described at *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=660118&id=817114&id=14307003&id=14311666&id=982645&id=14327944&id=894584&id=14351076&id=14525430&id=2013600628id=601468&id=14251771&id=14251987&id=14257034&id=14371751&id=14523591&id=14383376&id=695437&id=514547&id=170080238&id=14400782&id=14219851&id=764365&id=14505366&id=778332.*

[211] See, for example, the two accidents described at *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=14371751&id=660118.*

[212] OSHA proposed 51 volts as the low end of the avoid-contact range. The final rule adopts 50 volts as the low end for consistency with Table R–6 in existing § 1910.269 and IEEE Std 516–2009.

[213] IEEE Std 516–2009 assumes that MAID and MTID have the same value in this voltage range. Using this approach, the electrical component of the minimum approach distance would be the same in air or along the length of an insulated tool.

[214] The withstand voltage is the voltage at which sparkover is not likely to occur across a specified

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 the table through interpolation.[215]

These steps are illustrated in Table 7.

TABLE 7—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 6	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

This method is consistent with the method OSHA used to develop the minimum approach distances for voltages of 751 volts to 72.5 kilovolts in the 2005 proposal. Although OSHA received no comments on this approach, the methodology contained in final IEEE Std 516–2009 added one additional step (Ex. 0532). The distances in IEEE Std 4–1995 result from 60-Hz impulse rod-to-rod tests. The extra step in IEEE Std 516–2009 divides the phase-to-ground maximum transient overvoltage by 1.3 to account for the difference between the strength of an air gap under 60-hertz voltages and the strength under transient voltages.[216] The IEEE committee relied on two papers that are not in the current OSHA record to develop the 1.3 factor.[217]

OSHA is not adopting this part of the method that IEEE Std 516–2009 uses to calculate the electrical components of the minimum approach distances for voltages from 751 volts to 72.5 kilovolts. First, the Agency does not believe that there is sufficient information in this record to support the 1.3 conversion factor, which was not used in earlier editions of IEEE Std 516 and was not used in any version of the NESC through the 2007 edition.[218] Second, although OSHA raised this issue in its September 2009 reopening notice, no commenters voiced support for such a change in the OSHA rule. Finally, as previously noted, for voltages of 72.5 kilovolts and lower, IEEE Std 516–2009 assumes that the electrical component of the minimum approach distance is the same with tools in the air gap as it is for air alone. The dielectric strength of an air gap is less with a tool in the gap than it is when the gap is air, however (see, for example, Exs. 0556, 0558). Thus, an increase in the electrical component of the minimum approach distance is necessary to account for tools. OSHA does not believe that a 60-hertz-to-transient conversion factor (which reduces MAD values) is appropriate when no counterbalancing distance is added to account for tools in the air gap. For these reasons, the Agency is adopting the proposed methodology for determining the electrical component of the minimum approach distance for voltages of 751 volts to 72.5 kilovolts. As noted earlier, OSHA also is adopting the proposed ergonomic component for this voltage range. Thus, the final rule incorporates minimum approach distances for these voltages generally as proposed. However, Table V–5 in the final rule breaks the proposed voltage range of 751 volts to 15 kilovolts into two ranges—751 to 5,000 volts and 5.1 kilovolts to 15 kilovolts.

For the reasons described earlier under the discussion of the 301- to 750-volt range, IEEE Std 516–2009 sets the electrical component of the minimum approach distance at 0.02 meters for voltages of 301 to 5,000 volts.[219] As can be seen from Table 6, this is the sparkover distance for the smallest transient overvoltage listed in the table. There is no evidence in the record that lower voltages will produce larger sparkover distances. Consequently, there is no reason to believe that the electrical component of the minimum approach distance will be greater for voltages of 5,000 volts or less. In addition, rounding the electrical component of the minimum approach distance to the nearest 25 millimeters (1.0 inch) results in a minimum distance of 25 millimeters. As explained earlier, OSHA concludes that this value is reasonable and, therefore, adopts 0.02 meter (1 inch) as the electrical component of the minimum approach distance for this voltage range.

The electrical component of MAD—calculation methods for voltages over 72.5 kilovolts. As noted earlier, OSHA based its proposed minimum approach distances on criteria adopted by NESC Subcommittee 8 in 1993. The NESC based its criteria, at least in part, on IEEE Std 516–1987. As noted in Appendix B to proposed Subpart V, OSHA used the following equation, which was based on IEEE Std 516–1987, to calculate the electrical component of the minimum approach distance for voltages of 72.6 to 800 kilovolts in the proposed rule:

distance. It is the voltage taken at the 3σ point below the sparkover voltage, assuming that the sparkover curve follows a normal distribution.

[215] Draft 9 of IEEE Std 516 used curve-fitted equations rather than interpolation to determine the distance. The two methods result in nearly equivalent distances.

[216] A 60-hertz voltage cycles through its maximum, or peak, voltage 60 times each second, and the value of the voltage forms a sine wave. A transient overvoltage does not cycle, but generally increases quickly as a single pulse.

[217] These documents are (1) CIGRÉ/SC 33, "Phase-to-Phase Insulation Coordination," *ELECTRA*, no. 64, 1979; and (2) Esmeraldo, P. C. V., and Fonseca, C. S., "Evaluation of the Phase-to-Phase Overvoltage Characteristics due to Switching Surges for Application on Risk of Failure Statistical Methods in Non- Conventional Power Design," Paper 34.01, 6th ISH, New Orleans, 1989.

[218] The 2012 NESC adopts minimum approach distances from IEEE Std 516–2009, which, as noted, uses the 1.3 conversion factor.

[219] The electrical component of MAD is 0.02 meters (1 inch) for all voltages from 301 volts to 5.0 kilovolts. However, the ergonomic component of MAD is 0.305 meters (1 foot) for voltages up to 750 volts and 0.61 meters for higher voltages as explained earlier.

$$D = (C + a) \times pu \times V_{max} \qquad \textbf{Equation (1)}$$

Where:

D = Electrical component of the minimum approach distance in air in feet

C = 0.01 to account for correction factors associated with the variation of gap sparkover with voltage

a = A factor relating to the saturation of air at voltages [220] of 345 kilovolts or higher

pu = Maximum anticipated transient overvoltage, in per unit (p.u.)

V_{max} = Maximum rms system line-to-ground voltage in kilovolts—this value is the true maximum, that is, the normal highest voltage for the range (for example, 10 percent above the nominal voltage).

Phase-to-ground exposures. For phase-to-ground exposures, rulemaking participants agreed that the proposal's methodology for calculating minimum approach distances was generally appropriate unless insulated tools were present across the air gap. (See, for example, Exs. 0521, 0527.1, 0529, 0575.1.) For instance, EEI commented, "The existing MAID formula, based on rod-to-rod gap data, is acceptable for all line-to-ground applications [through 800 kilovolts with a maximum per-unit overvoltage of 2.44 per unit]" (Ex. 0527.1).

Therefore, the final rule requires employers to set minimum approach distances based on Equation 1 for phase-to-ground exposures at voltages of more than 72.5 kilovolts. Here is the full equation contained in Table V–2, with the part that is equivalent to Equation 1 highlighted:

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

The equation in Table V–2 is identical to Equation 1 except that it: (1) Incorporates an altitude correction factor, A, as described later in this section of the preamble, (2) converts the result to meters through multiplication by 0.3048, and (3) adds the ergonomic component of MAD, M to the electrical component of MAD given in Equation 1. In addition, the table uses slightly different variable designations: V_{L-G} for V_{max} and T for pu.

As explained earlier in this section of the preamble, OSHA decided to specify minimum approach distances that account for the presence of tools in the air gap unless the employer can demonstrate that there is only air between the employee and the energized part or between the employee and ground, as appropriate. (The air gap would be between the employee and the energized part if the employee is at ground potential, or at the potential of another energized part, or between the employee and ground if the employee is at the potential of the energized part during live-line barehand work.) Consequently, in the equation for phase-to-phase system voltages of more than 72.5 kilovolts in Table V–2, the term C must be adjusted depending on whether the minimum tool-insulation distance or the minimum air-insulation distance will be used as the electrical component of the minimum approach distance. According to IEEE Std 516–2009, C is 0.01 for the minimum air-insulation distance and 0.011 for the minimum tool-insulation distance. OSHA concludes that these values of C are reasonable because they are supported by scientific evidence (Exs. 0556, 0558) and because there were no other values recommended in the rulemaking record for the proposal. Therefore, these values are incorporated in Table V–2 in the final rule.

There is one other minor issue that requires resolution before the electrical components of the minimum approach distances for phase-to-ground exposures can be calculated—that is, the determination of the saturation factor, a. The proposed rule and IEEE Std 516–1987, which formed the original basis for the calculation of phase-to-ground minimum approach distances in existing § 1910.269, relied on Figure 2 in "Recommendations for Safety in Live Line Maintenance" to determine the saturation factor (269-Ex. 60; Ex. 0558). That figure plotted the saturation factor against crest voltage. In preparing IEEE Std 516–2009, the IEEE committee decided to use equations to represent the saturation factor rather than reading it from the figure (Ex. 0532). The committee used a curve-fitting program to develop the following equations for the saturation factor for calculating the electrical components of the minimum approach distances for phase-to-ground exposures: [221]

[220] This voltage is the maximum transient overvoltage.

[221] These equations calculate the saturation factor, a, for any exposure for which Equation 1 is used to calculate the electrical components of the minimum approach distances. However, as explained later in this section of the preamble, the committee chose to apply Equation 1 only to phase-to-ground exposures.

1. For peak phase-to-phase voltages, V_{Peak}, less than 635 kilovolts,[222] the saturation factor, a, equals 0.

2. For V_{Peak} from 635.1 to 915.0 kilovolts,

$$a = \frac{V_{Peak} - 635}{140,000}$$

3. For V_{Peak} from 915.1 to 1,050.0 kilovolts,

$$a = \frac{V_{Peak} - 645}{135,000}$$

4. For V_{Peak} from 1050.1 to 1,600 kilovolts,

$$a = \frac{V_{Peak} - 675}{125,000}$$

OSHA concludes that adopting IEEE's method of calculating the saturation factor is reasonable because that method will lead to more accurate and consistent determinations of minimum approach distances for phase-to-ground exposures on system voltages of more than 72.5 kilovolts than approximating the saturation factor by reading it directly from the graph, as was done to calculate the minimum approach distances in existing § 1910.269.[223] Consequently, the Agency is adopting these equations for calculating the saturation factor in Table V–2 in the final rule for phase-to-ground exposures, except for the 1,600-kilovolt limitation for the last voltage range. As explained later in this section of the preamble, the Agency concluded that extrapolating the saturation factor beyond the 1,600-kilovolt maximum switching impulse used during the experimental testing used to support the IEEE method is reasonable and will better protect employees than alternative approaches. For phase-to-ground exposures, this limit would have no practical effect as the Agency anticipates that few, if any, systems will have maximum phase-to-ground transient overvoltages (V_{Peak}) as high as 1,600 kilovolts.

Phase-to-phase exposures. For phase-to-phase exposures, OSHA based the proposal on the 2002 NESC approach, which used the maximum phase-to-phase transient overvoltage in Equation 1 for calculating the electrical components of minimum approach distances for phase-to-phase exposures. As noted in Appendix B to proposed Subpart V, OSHA used the following equation to determine the phase-to-phase maximum transient overvoltage based on a system's per-unit nominal voltage phase-to-ground crest:

$$pu_p = pu_g + 1.6 \qquad \textbf{Equation (2)}$$

Where:

pu_p = p.u. phase-to-phase maximum transient overvoltage, and

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

The value for pu_p was to be used for pu in Equation (1) for calculating the phase-to-phase MADs.

Until approximately 2007, the technical committees responsible for IEEE Std 516 and the NESC calculated minimum approach distances based on these equations. Because OSHA was using the same methodology, the Agency relied on the technical committees' calculations as they appeared in IEEE Std 516–2003 and the 2002 NESC and proposed to include those distances in § 1910.269 and subpart V.

During the revision cycle for IEEE Std 516–2009, the IEEE technical committee responsible for revising that standard identified what, in the committee's view, was an error in the calculations of phase-to-phase minimum approach distances for nominal voltages 230 kilovolts and higher. At these voltages, the saturation factor, a, which appears in Equation (1), varies depending on the voltage; that is, the value of a increases with increasing voltage. The NESC subcommittee calculated the phase-to-phase minimum approach distances for the 1993 NESC using a value for the saturation factor, a, corresponding to the maximum phase-to-ground transient overvoltage, rather than the maximum phase-to-phase transient overvoltage.[224]

Because, in its proposal, OSHA borrowed the minimum approach distances from IEEE Std 516–2003 and the 2002 NESC, the Agency twice solicited comments on whether changes to its rule were necessary in light of the

[222] Through an apparent oversight, the IEEE equations for a fail to cover 635.0 kilovolts.

[223] The quality of the graph is poor, and the underlying data is no longer available (Ex. 0532).

[224] ANSI/IEEE Std 516–1987 did not contain distances for phase-to-phase exposures. The NESC subcommittee derived them by applying the IEEE equation, Equation (1), to the phase-to-phase temporary overvoltages calculated using Equation (2).

errors identified by the IEEE committee (73 FR 62942, 74 FR 46958).

The consensus among rulemaking participants was that the proposed rule's minimum approach distances for phase-to-phase exposures at maximum transient overvoltages exceeding approximately 630 kilovolts involved a mathematical error. (See, for example, Exs. 0521, 0524, 0526.1, 0528, 548.1; Tr2. 122–123, 139.) Draft 9 of the 2009 revision of IEEE Std 516 derived formulas for the saturation factor, *a*, using a curve-fitting program (Ex. 0524). When maximum phase-to-phase transient overvoltages are less than 630 kilovolts, *a* is 0.0, and the mathematical error is not present (*id.*). For higher maximum transient overvoltages, *a* is a function of the peak voltage, which is higher for phase-to-phase exposures than it is for phase-to-ground exposures (*id.*)

Because the proposed rule used an approach for calculating phase-to-phase minimum approach distances that commenters generally agreed was in error, OSHA decided to make changes in this final rule to account for that mistake.

To determine the increased risk to employees, OSHA compared the probability of sparkover for the electrical component of the largest proposed minimum approach distance with the probability of sparkover for the electrical component of the corrected minimum approach distance.[225] For systems operating at 800 kilovolts, the probability of sparkover with the maximum phase-to-phase transient overvoltage at the corrected electrical component of the minimum approach distance is approximately 1 in 1,000. The probability of sparkover at the proposed electrical component of the minimum approach distance is 64 in 100. Clearly, the proposed minimum approach distance poses significant risk to employees when the phase-to-phase transient overvoltage is at its maximum. Because, for systems operating at 800 kilovolts, the minimum approach distance in the existing standard is the same as the distance in the proposed rule, the existing standard also poses a substantial risk to employees.

OSHA calculated the probabilities of sparkover at the proposed electrical component of the minimum approach distance and the corrected minimum approach distance in the following manner. The minimum approach distance proposed in Table V–2 for this exposure was 7.91 meters, and the electrical component of this distance was 7.60 meters (7.91 meters − 0.31 meters). The phase-to-phase maximum transient overvoltage at 800 kilovolts is 2,352 kilovolts.[226] Draft 9 of the 2009 revision of IEEE Std 516 derived formulas for the saturation factor, *a*, using a curve-fitting program. Equation 59 in that draft standard provided the following equation for *a* for maximum transient overvoltages of more than 1,485 kilovolts:

$$a = (TOV - 1{,}485) \times 0.00000491 + 0.0055704,$$

where *TOV* is the maximum transient overvoltage (Ex. 0524).

This equation extrapolates *a* beyond the 1,600-kilovolt upper limit on available rod-gap test data. Using this equation to determine *a* and using that value in Equation 1, the withstand voltage corresponding to 7.60 meters is 1,966 kilovolts. The critical sparkover voltage for a 7.60-meter gap is 1,966 ÷ 0.85, or 2,312, kilovolts. (See Step 4 in the explanation of how to use Table 6 to determine the electrical component of clearance earlier in this section of the preamble.) The probability of sparkover for this distance at the maximum transient overvoltage of 2,352 kilovolts is 64 percent.[227] This percentage means that the electrical component of the proposed minimum approach distance at 800 kilovolts has a probability of 64 percent of sparking over at the industry-accepted maximum per-unit transient overvoltage of 2.0.

There were three basic methods submitted to the record for calculating minimum approach distances for phase-to-phase exposures. The first method was the one OSHA used in developing the proposed rule. As described earlier in this section of the preamble, that method used Equation (1) and Equation (2) to determine the minimum approach distance, but without adjusting the saturation factor, *a*, in Equation (1) to account for the increase between the phase-to-ground and phase-to-phase maximum transient overvoltage. For the reasons already explained, OSHA concludes that this method is invalid and would expose employees to an unreasonable increase in risk for phase-to-phase exposures at maximum transient overvoltages higher than 630 kilovolts. Consequently, the Agency decided against adopting this method in the final rule.

The second method, adopted by IEEE Std 516–2009, uses equations based on the paper by Vaisman,[228] and two papers by Gallet,[229] to determine minimum approach distances (Ex. 0532). OSHA refers to this method as the "IEEE method" in the following discussion.

The formula used in IEEE Std 516–2009 for calculating phase-to-phase minimum approach distances for voltages of 72.6 kilovolts and higher is derived from testing that replicates line configurations rather than live-line work. Accordingly, the underlying formula in IEEE Std 516–2009 originally was intended for determining appropriate conductor spacing rather than for determining minimum approach distances appropriate for employees performing live-line work. To account for the presence of an employee working in an aerial lift bucket within the air gap between the two phase conductors, the IEEE committee incorporated the concept of a floating electrode in the air gap. The committee's approach to determining the electrical component of the minimum approach distance can be summarized as follows:

1. Start with a formula to calculate the critical sparkover voltage for the distance between two conductors.

2. Modify the formula to account for a 3.3-meter floating electrode representing an employee working within an aerial lift bucket between the phase conductors.

3. Modify the formula to convert the critical sparkover voltage to a withstand voltage.

[225] The corrected minimum approach distance is the minimum approach distance calculated with an extrapolated saturation factor for the maximum phase-to-phase transient overvoltage in place of the maximum phase-to-ground transient overvoltage. This is the method used in IEEE Std 516 Draft 9 (Ex. 0524).

[226] Using Equation 2, the phase-to-phase maximum per-unit transient overvoltage is 2.0 + 1.6, or 3.6, times the peak phase-to-ground voltage. The peak phase-to-ground voltage is the maximum system phase-to-phase voltage times $\sqrt{2}$ divided by $\sqrt{3}$. Thus, the maximum transient overvoltage for a phase-to-phase exposure for a maximum system voltage of 800 kilovolts (the highest system voltage) is $3.6 \times 800 \times \sqrt{2} \div \sqrt{3}$, or 2,352, kilovolts.

[227] The probability of sparkover is determined by normalizing the mean (average) sparkover voltage and the standard deviation and looking up those two normalized parameters in standard distribution tables. The critical sparkover voltage (that is, the mean voltage that will spark over) is 2,312 kilovolts. The standard deviation is 5 percent of this value, or 115.6 kilovolts. The maximum transient overvoltage corresponding to the industry-accepted value of 2.0 per unit at 800 kilovolts is 2,352 kilovolts, or 0.346 standard deviations above the mean voltage at sparkover. The probability of sparkover can be determined from normal distribution tables for a *Z* of 0.346.

[228] Vaisman, *op cit.*

[229] Gallet, G., Leroy, G., Lacey, R., and Kromer, I., "General expression for positive switching impulse strength valid up to extra line air gaps," *IEEE Transaction on Power Apparatus and Systems*, vol. PAS–94, pp. 1989–1993, Nov./Dec. 1975 (Ex. 0560); and Gallet, G., Hutzler, B., and Riu, J–P., "Analysis of the switching impulse strength of phase-to-phase air gaps," *IEEE Transactions on Power Delivery*, vol. PAS–97, no. 2, Mar./Apr. 1978 (Ex. 0553).

4. Determine the maximum transient overvoltage on the line, and substitute that value for the withstand voltage.

5. Rearrange the equation to solve for distance.

In more technical detail, this approach is described as follows:

1. The equation for calculating the critical sparkover voltage for a given distance between two conductors includes a gap factor, *k*. This factor depends on several variables:

alpha = the proportion of the negative switching impulse voltage to the total phase-to-phase impulse voltage,

$D_{design\ L\text{-}L}$ = the design phase-to-phase clearance, and

H = the average height of the phase above the ground.

Table 8 shows the values recommended by IEEE Std 516–2009 for these variables and the resultant gap factors.

TABLE 8—IEEE STD 516–2009 GAP FACTORS (*k*)

Phase-to-phase voltage	*alpha*	$D_{design\ L\text{-}L}/H$	*k*
≤ 242 kV	0.33	0.8	1.451
> 242 kV	0.41	0.8	1.530

IEEE Std 516–2009 uses the following equation to calculate the critical sparkover voltage for the designed gap between two phase conductors:

$$V_{50} = \frac{3,400(k)}{1+\frac{8}{D_{l\text{-}l}}}$$

Where:

V_{50} = the critical sparkover voltage in kilovolts,

k = the gap factor from Table 8, and

$D_{l\text{-}l}$ = the sparkover distance in meters.

2. When an employee performs live-line barehand work, the employee typically is positioned between two or more phase conductors. The employee could be working, for example, from an aerial lift platform or a conductor cart. These devices and the worker are both conductive. The presence of a conductive object in the air gap between the two electrodes (which, in this case, are the two conductors) reduces its dielectric strength. IEEE Std 516–2009 introduces a constant, K_F, to account for the presence of the employee and other conductive objects in the air gap. In that consensus standard, K_F equals 0.9 to accommodate a 3.3-meter conductive object in the air gap. This value is equivalent to a 10-percent reduction in the dielectric strength of the gap.

With this factor included, the equation for the critical sparkover voltage is:

$$V_{50} = \frac{3,400(k)(K_F)}{1+\frac{8}{D_{l\text{-}l}}}$$

3. IEEE sets the withstand voltage at a level that is 3σ lower than the critical sparkover voltage, as indicated in the following equation:

$V_W = (1 - 3\sigma)V_{50}$

Where:

V_W = the withstand voltage,

V_{50} = the critical sparkover voltage, and

σ = 5 percent for a normal distribution.

4. To solve for the electrical component of the clearance, the maximum transient overvoltage is substituted for the withstand voltage. The IEEE committee used the following equation to calculate the maximum transient overvoltage on the line:

$$T_{L\text{-}L} = 1.35T_{L\text{-}G} + 0.45 \qquad \textbf{Equation (3)}$$

Where:

$T_{L\text{-}L}$ = the phase-to-phase maximum transient overvoltage in per unit, and

$T_{L\text{-}G}$ = the phase-to-ground maximum transient overvoltage in per unit.

5. Substituting the values of the various constants and solving these equations for distance, IEEE Std 516–2009 uses the following equations to calculate the minimum air-insulation distance:

For voltages less than or equal to 242 kilovolts:

$$D_{L\text{-}L} = \frac{8}{\left(\frac{4,621}{((1.35T_{L\text{-}G})+0.45)V_{L\text{-}L}}\right)}$$

For voltages more than 242 kilovolts:

$$D_{L\text{-}L} = \frac{8}{\left(\frac{4,875}{((1.35T_{L\text{-}G})+0.45)V_{L\text{-}L}}\right)}$$

Where:

$D_{L\text{-}L}$ = the minimum air-insulation distance (the minimum distance needed to prevent sparkover with air alone as the insulating medium),

$T_{L\text{-}G}$ = the phase-to-ground maximum transient overvoltage in per unit, and

$V_{L\text{-}L}$ = the rms phase-to-phase system voltage.

Testifying on behalf of EEI, Dr. Horton explained the IEEE method as follows: is well recognized that the dielectric strength of a given electrode geometry is different for line-to-ground surges than for line-to-line surges. A phase-to-phase surge between two phases is the voltage difference between the phase-to-ground surges which may be of opposite polarity and displaced in time, (and many times are) whereas a maximum phase-to-ground surge is considered uni-polar.

* * * * *

[The surges from the two phases] are displaced by some amount of time. . . .

The resulting line-to-line surge . . . will stress a given air gap geometry differently than either of the line-to-ground surges that the resulting waveform is comprised of. Unlike line-to-ground insulation characteristics of a given electrode geometry, which depend primarily on the gap spacing, line-to-line insulation characteristics . . . are more complex because one of the surges has a positive polarity with respect to ground while the other has a negative polarity with respect to ground.

The resulting insulation strength is a function of alpha, which again, is the ratio of the negative surge to the sum of the negative and positive surge.

The IEEE recently tried to address this limitation [in IEEE Std 516–2009] by developing a method based on a modified version of the Gallet equation. The upper voltage limit of the resulting equation is 3500 kV peak or air gap distances of up to 15 meters. This limitation is well within the typical range of live-line working scenarios in the United States.

Historically, IEEE Standard 516 has used rod-to-rod electrode geometry data for determining line-to-ground MAID. One reason for this is that the test data that the method is based on represents a rod-to-rod electrode configuration.

In addition, the line-to ground [testing] that was performed showed that the rod-to-rod results were in the middle range for a wide range of conductor configurations. The rod-to-rod data presented neither the worst case nor the best. Thus, it was chosen as a reasonable representation of all the possible gap configurations to which a line worker might be exposed while performing tasks, which are characterized as line-to-ground.

When considering line-to-line minimum air insulation distances, a rod-to-rod gap may not be the most appropriate. Typically, the worker will bond onto one phase and will not need to bridge the gap to the other phase. Since the shape of the adjacent electrode remains unchanged during the task, (in other words it remains a conductor) the resulting air gap geometry more closely resembles that of a conductor-to-conductor. The effect of the change in geometry of the phase to which the worker is bonded is dealt with in the new IEEE method by introducing an additional factor that accounts for the effect of large conductive objects floating in the air gap. [Tr2. 83–86]

No rulemaking participant recommended that OSHA adopt the IEEE method for calculating minimum air-insulation distances for phase-to-phase exposures at more than 72.5 kilovolts. In addition, the Agency has several concerns with the approach taken in that consensus standard. First, the IEEE method relies on test data for an electrode configuration that is not comparable to the rod-to-rod gap used for phase-to-ground exposures on which OSHA based the minimum approach distances in existing § 1910.269. Second, the choices for some of the parameters used in the equations for the electrical component of the minimum approach distance appear to be arbitrary. Third, the IEEE method is based on papers that explore the dielectric strength of electric power lines rather than the dielectric strength of circuit parts configured as they would be when employees are performing live-line barehand work.

(1) Conductor-to-conductor-based method does not accurately model employee exposure. OSHA considered the evidence in the record and concludes that the IEEE method, which is based on testing on conductor-to-conductor electrodes, does not accurately model employee exposure. As noted by Dr. Horton, the approach taken by existing § 1910.269 and earlier editions of IEEE Std 516 based the calculation of minimum air-insulation distances for both phase-to-ground and phase-to-phase exposures on phase-to-ground testing of rod-to-rod electrodes (Tr2. 85).[230] By adopting the approach taken in IEEE Std 516–1987 in promulgating existing § 1910.269, OSHA deemed it reasonable to rely on rod-to-rod gap data (59 FR 4383–4384). The record in this rulemaking contains reports of tests on a variety of electrode configurations, showing clearly that the dielectric strength of air varies with the configuration (269-Ex. 60; Exs. 0553, 0554). In reviewing the record, OSHA has again concluded that *phase-to-ground* rod-to-rod gap test data forms a reasonable basis for the determination of minimum approach distances because it falls in the middle range of various electrode configurations (that is, it is neither the best case nor the worst). In addition, OSHA believes that employees performing work on energized lines are rarely exposed to the worst-case configuration, rod-to-plane electrodes, or to the best-case configuration, sphere-to-sphere electrodes. Thus, an exposure representing the middle range of various electrode configurations is reasonable for a model based on phase-to-ground testing.

A paper by Gallet[231] reports on a variety of *phase-to-phase* gap factors, including supported busbars and asymmetrical geometries, as shown in the following table (Ex. 0553):

Electrode geometry	*alpha* = 0.5	*alpha* = 0.33
Rings or large, smooth electrodes	1.80	1.70
Crossed conductors	1.65	1.53
Rod-rod or conductor-conductor	1.62	1.52
Supported busbars	1.50	1.40
Asymmetrical geometries	1.45	1.36

Table reprinted with permission from the Institute for Electrical and Electronics Engineers (IEEE). OSHA revised the table from IEEE's original.

Although the performance during phase-to-phase tests are the same for rod-to-rod and conductor-to-conductor electrodes, OSHA concludes that phase-to-phase exposures are more likely to correspond to asymmetrical geometries, which, as can be seen from the table in the Gallet paper, have a lower dielectric strength than rod-to-rod or conductor-

[230] Typical configurations include rod-rod, rod-plane, and conductor-plane. The terminology refers to the configuration of the two electrodes. For example, in a rod-plane configuration, one of the electrodes is a rod perpendicular to an electrode in the shape of a plane.

[231] Gallet, G, Hutzler, B., and Riu, J–P., *op cit.*

to-conductor electrodes.[232] Employees performing live-line barehand work face a wide variety of exposure conditions reflecting a number of different electrode configurations. Several of these electrode configurations are not equivalent to conductor-to-conductor electrodes. Employees working on energized supported busbars could experience phase-to-phase exposures. Additionally, during live-line barehand work on energized conductors, employees are working on the conductors, and the installation may be configured differently when maintained or installed. For example, a damaged portion of a bundled conductor may protrude from the bundle, or an employee may be holding an armor rod perpendicular to the conductor. The equipment used to position the employee also can affect the shape of one of the electrodes. The Agency believes that these examples may more closely resemble asymmetrical geometries. Consequently, the gap factor for those electrode configurations, as shown in the table, would be lower than the gap factor used in IEEE Std 516–2009. The IEEE standard reduced the gap factor by accounting for a conductive object in the gap. However, the Agency believes that such a reduction also would be necessary when another conductive object is in the air gap while an employee is working on an energized conductor, which could occur as equipment is transferred to the employee or if a second worker is in the air gap. Thus, OSHA concludes that a model based on phase-to-phase testing should be based on asymmetrical electrode geometries and that the IEEE committee's choice of a conductor-to-conductor gap is not appropriate.

[232] Dielectric strength is proportional to the gap factor. Thus, a smaller gap factor yields a lower dielectric strength.

(2) The values of some of the parameters used in the IEEE method appear to be arbitrary. The ratio of the negative switching impulse voltage to the total phase-to-phase impulse voltage is designated as *alpha*. Dr. Horton described this parameter, and its importance, as follows:

> A phase-to-phase surge between two phases is the voltage difference between the phase-to-ground surges which may be of opposite polarity and displaced in time, (and many times are) whereas a maximum phase-to-ground surge is considered uni-polar.
>
> [Figure 5] shows how two separate phase-to-ground surges combine to form a line-to-line surge. . . .
>
> [W]e have one [transient] for phase 1 and we have . . . one for phase 2, and . . . they are displaced by some amount of time. The resulting transient overvoltage or surge that would be across the air gap, which would be the line-to-line air gap, would be . . . a combination of the [two] curve[s]. [Tr2. 83–84]

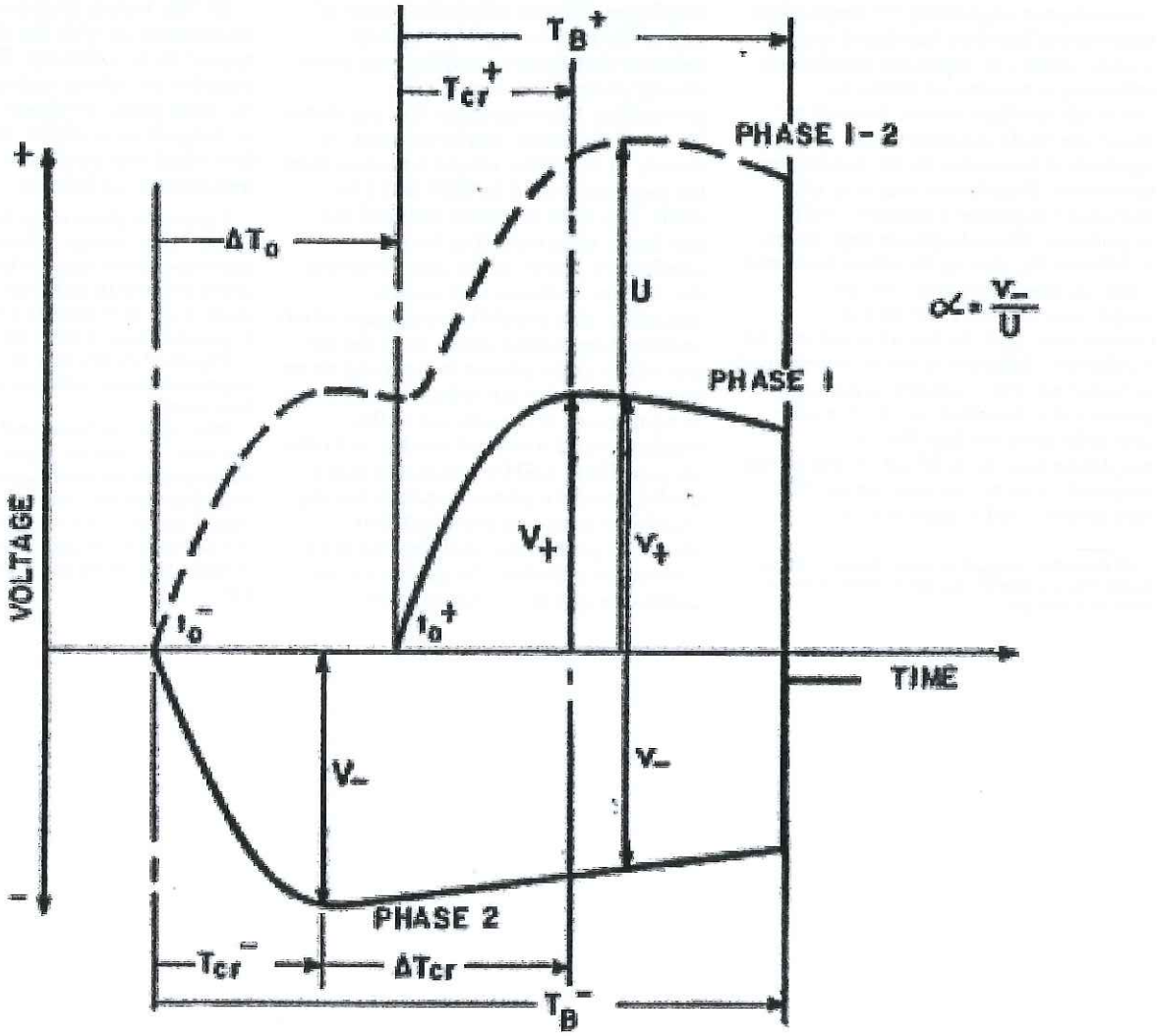

Figure 5--Graphical Depiction of Phase-to-Phase Transient Overvoltage[233]

The IEEEcommittee used an *alpha* of 0.33 for system voltages up to 242 kilovolts. However, the committee used a value of 0.41 for higher system voltages. It described the rationale for this latter decision with a quote from the Vaisman paper:

In [extra-high voltage] systems, where there is efficient overvoltage control and hence the overvoltage factor a tends to lie in the range of 0.41 to 0.50, the ratio between the line-to-line (D1) and the line-to-ground (D) clearance equal to 2.0 is the one which provides a more balanced distribution of flashovers between the two gaps. [Ex. 0532]

OSHA has two concerns about this choice. First, the paper does not indicate that an *alpha* of 0.41 is the smallest expected for these systems. A smaller value of *alpha* will produce a smaller value for the gap factor, *k*, and, consequently, a larger electrical component of the minimum approach distance.[234] Second, it is not clear why efficient overvoltage control has any effect on *alpha*. Overvoltage control limits the maximum transient overvoltage on each individual phase, but it does not necessarily limit the delay between the peak transient overvoltage on each phase, which appears as ΔT_{cr} in Figure 5. The Vaisman paper also explored the effect of ΔT_{cr}, which is not accounted for in the IEEE method:

In other tests, where only the negative wave was displaced, the observed reductions were:

[233] Figure 5, which is a copy of Figure 4 from Ex. 0545.1, was included in the presentation by Dr. Horton at the October 28, 2009, public hearing. (See, also, Ex. 0567.) EEI identified the source of this figure as *EPRI Transmission Line Reference Book: 115–345-kV Compact Line Design,* 2007 (Blue Book).

[234] In the IEEE method, the critical sparkover voltage, V_{50}, is directly proportional to *k*, and the minimum air-insulation distance (the electrical component of the minimum approach distance) is inversely proportional to V_{50}. Thus, the electrical component of the minimum approach distance is inversely proportional to *k*.

TABLE 2—REDUCTION IN [V_{50}] WHEN DISPLACING THE NEGATIVE WAVE

[*alpha*] Desired	[*alpha*] Obtained	ΔT_{cr} (ms)	Reduction (%)
0.33	0.28	1	1.5
0.50	0.43	1	3.1
0.33	0.22	2	4.0
0.50	0.36	2	8.7

Nevertheless, under these conditions, besides the shift between impulses, there was also a decrease of [*alpha*].

From all the results a maximum reduction of 8.7% in the value of U50 can be observed when the positive and negative components of phase-to-phase overvoltage are not synchronized [Ex. 0555].

From Figure 5, it is clear that the maximum overvoltage occurs when the positive and negative transient waves are synchronized, that is, when $\Delta T_{cr} = 0$. In addition, it is clear from the BPA report that the poles of a circuit breaker do not trip simultaneously (Ex. 0575.1). In addition, circuit characteristics also may contribute to the size of ΔT_{cr}. The ΔT_{cr} range shown in the Vaisman paper does not seem unreasonable. Thus, from this paper, on which the IEEE committee relied, it appears that the maximum phase-to-phase transient overvoltage should be calculated, as shown by Table 2 in the Vaisman paper, by using an *alpha* of 0.50 and reducing the critical sparkover voltage by 8.7 percent. In this case, the peak overvoltage on each phase has the same value, which seems reasonable if the phases are identical in most respects, but displaced by 2 milliseconds, which, based on the BPA report, also seems reasonable.

(3) The IEEE method is based on papers on the design of lines rather than employee safety during maintenance. Finally, OSHA has a concern that the IEEE method is based almost exclusively on papers that explore the dielectric strength of lines. Employees perform work on energized lines *and equipment.* In addition, the lines on which employees work during maintenance and repair may not be in the same condition as the lines were when they were first installed. The Agency believes that it is appropriate to base minimum approach distances for workers on papers and scientific data derived from actual working conditions.

The Agency agrees with Dr. Horton and EEI that phase-to-phase overvoltages are more complicated than phase-to-ground overvoltages. However, the Gallet formula on which the IEEE method is based models phase-to-ground, as well as phase-to-phase, critical sparkover voltages. In addition, the IEEE committee chose not to use it for phase-to-ground exposures, presumably because the papers supporting the method for phase-to-ground exposures examined the safety of employees performing live-line maintenance.[235] OSHA believes that these papers support the method used in the final rule to calculate minimum approach distances for phase-to-phase exposures, as well as phase-to-ground exposures. Therefore, for all the foregoing reasons, OSHA concludes that the IEEE approach does not reasonably represent the range of overvoltages or the dielectric strength of air gaps that a worker will encounter during phase-to-phase exposures.

The third method, described in Drafts 9 and 10 of IEEE Std 516 and incorporated in this final rule, uses Equation (3)[236] to determine the maximum per-unit transient overvoltage, calculates the saturation factor, *a,* based on the maximum phase-to-phase transient overvoltage, and uses Equation (1)[237] to determine the minimum approach distance (Exs. 0524, 0525). The calculation of the saturation factor uses a curve-fitted equation, which extrapolated the value for that factor beyond the 1,600-kilovolt limitation on the test data noted earlier. OSHA refers to this method as the "extrapolation method" in the following discussion. In comments responding to the 2008 reopening notice, Mr. Brian Erga with ESCI supported the adoption of this method because it corrects the calculation error present in the 2003 edition of IEEE Std 516 (Ex. 0521).

Other rulemaking participants objected to the extrapolation of the saturation factor. (See, for example, Exs. 0545.1, 0548.1; Tr2. 77–79.) These rulemaking participants maintained that there was no test data to support extrapolating this factor and argued that other methods of estimating the dielectric strength of air demonstrated that extrapolating the saturation factor would result in minimum approach distances that are "dangerously inaccurate" (Ex. 0548.1). The Southern Company explained its objections as follows:

> [T]here are at least two methods of estimating the dielectric strength of air gaps that show that extrapolating the saturation factor, "a", beyond the test data [reference omitted] for which it was based is not valid. A comparison of the MAID values computed using the [extrapolation] formula and those of Gallet and CRIEPI[238] [references omitted] show that extrapolating test points beyond the 1650 kV range is dangerously inaccurate. [*Id.*]

The Southern Company described how it "manipulated" the formulas and plotted the results, comparing the extrapolation method with the other two methods (the Gallet and CRIEPI formulas), as shown in Figure 6.

[235] IEEE Std 516–2009 listed three papers that supported the method used for phase-to-ground exposures:

Elek, A., and Simpson, J. W., "Safe clearance and protection against shocks during live-line work," *AIEE Transaction on Power Apparatus and Systems,* vol. 80, pt. III, pp. 897–902, Feb. 1962.

IEEE Committee Report, "Live-line maintenance methods," *IEEE Transactions on Power Apparatus and Systems,* vol. PAS–92, pp. 1642–1648, Sept./Oct. 1973.

IEEE Committee Report, "Recommendations for safety in live-line maintenance," *IEEE Transactions on Power Apparatus and Systems,* vol. PAS–87, no. 2, pp. 346–352, Feb. 1968.

All three of these papers examined minimum approach distances for live-line work (Ex. 0532).

[236] $T_{L-L} = 1.35T_{L-G} + 0.45$. OSHA is adopting this equation in Table V–2. Drafts 9 and 10 of IEEE Std 516 and final IEEE Std 516 adopt this equation for calculating the phase-to-phase maximum per-unit transient overvoltage (Exs. 0524, 0525, and 0532), and there is no evidence in the record to indicate that it does not accurately represent the phase-to-phase maximum per-unit transient overvoltage.

[237] $D = (C + a) \times pu \times V_{max}$.

[238] Central Research Institute of Electric Power Industry.

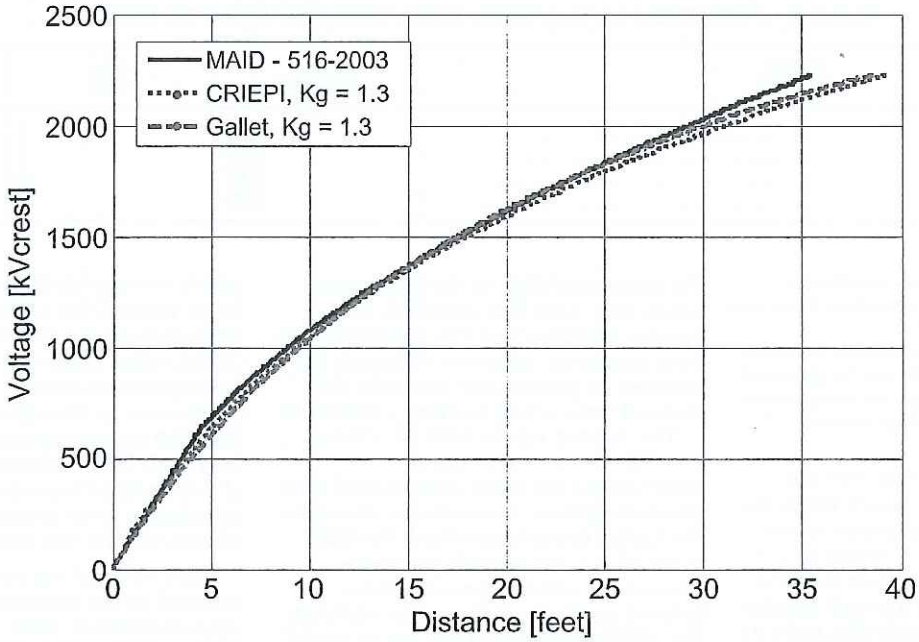

Figure 6—Comparison of Extrapolation Method with Gallet and CRIEPI Formulas

Southern Company included a second figure (not shown here) consisting of the area beyond 1,600 kilovolts, where test data is unavailable to support either Equation (1) or the determination of the saturation factor, *a*. The commenter concluded:

> [These figures] show that three methods agree rather closely for transient overvoltages less than 1600 kV (the limitation of the [Drafts 9 and 10] IEEE method). However, at approximately 1800 kV, the results found using the Gallet and CRIEPI formulas diverge significantly from the [extrapolation] method. The reason for this is primarily due to the fact that the Gallet and CRIEPI formulae are based on test data in this voltage range, whereas, the [extrapolation] formula is not. [*Id.*]

OSHA notes that there is a similar divergence between these formulas at voltages from 600 to 750 kilovolts. The following table shows minimum air-insulation distances for two voltages [239] using the Equation (1) extrapolation method and Southern Company's modified Gallet formula:

Voltage	Equation (1) based on extrapolation method [1]	Modified gallet formula	Percent difference
592.8 kV	1.28 meters	1.50 meters	17
2149.0 kV	9.23 meters	10.68 meters	16

[1] Based on IEEE Standard 516 Draft 9 (Ex. 0524).

This table shows a substantial difference between the Southern Company's modified Gallet formula and the extrapolation method at voltages where test data exist. Southern Company's modified Gallet formula produces minimum approach distances that are much higher at voltage levels where test data exist than they are where test data do not exist. Because the modified Gallet formula does not accurately produce minimum approach distances where test data exists, there is no reason to believe that it will accurately calculate minimum approach distances where there is no test data. Therefore, OSHA concludes that it cannot rely on the Southern Company's analysis to show that the extrapolation method does not provide adequate employee protection.[240] The results of this comparison are not surprising. The curves representing these formulas have slightly different shapes. In comparison to Equation (1), in which the saturation factor increases nearly linearly before and after extrapolation, the Gallet formula results in a small increase in the saturation factor at lower voltages, but a large increase at higher voltages. Thus, despite the similarity in appearance between the two equations, OSHA concludes that, compared to the extrapolation method, the modified Gallet formula does not equally represent the strength of the air gap.

Further exploration of the modified Gallet and CRIEPI formulas sheds additional light on this issue. The Gallet formula uses a gap factor as one parameter. Southern Company used a gap factor of 1.3 in its comparison. Although the comment stated that Southern Company based the gap factor on rod-to-rod electrode configurations,

[239] OSHA chose 592.8 and 2,149 kilovolts (which correspond to systems of 161 kilovolts at 3.0 per-unit maximum transient overvoltage and 800 kilovolts at 2.1 per-unit maximum transient overvoltage) because these values generally represent the low and high end of the voltage range covered by Figure 6. In addition, there is rod-gap test data supporting the current method at 592.8 kilovolts, but not at 2,149 kilovolts.

[240] The Agency did not compare the modified CRIEPI formula as there is no evidence in the record to suggest that OSHA base the final rule on that formula.

there is no record support for this value. The lowest value for the gap factor provided in the Gallet paper was 1.36 (Ex. 0553). Had Southern Company used a gap factor of 1.33 instead,[241] the differences between the equations would be generally smaller, and the high-voltage "difference" noted by Southern Company would not be apparent until approximately 2,100 kilovolts. At system voltages higher than 242 kilovolts, IEEE Std 516–2009 uses a gap factor equivalent to 1.377, which results in smaller rather than larger minimum air-insulation distances at voltages between approximately 800 and 2,200 kilovolts (Ex. 0532). Therefore, the Agency is rejecting Southern Company's argument that the modified Gallet and CREIPI formulas show that the extrapolation method is not sufficiently protective.

The concern about the lack of test data appears to be unfounded, at least for the range of overvoltages addressed by the final rule. The largest overvoltage addressed by the final rule is approximately 2,500 kilovolts, which corresponds to an 800-kilovolt system with a phase-to-ground maximum per-unit transient overvoltage of 2.5 pu. The test data for rod-to-rod gaps extends to 1,600 kilovolts. Thus, the data cover about two thirds of the voltage range covered by the final rule, and the test data provide substantial support for maximum transient overvoltages of 1,600 kilovolts (which corresponds to an 800-kilovolt system with a 1.5 per-unit maximum transient overvoltage) regardless of whether the exposure is phase-to-phase or phase-to-ground. In addition, the saturation factor varies almost linearly with voltage, as can be seen from the table and graphs of voltage vs. saturation factor in the IEEE reports on which Equation (1) is based (Exs. 0556, 0558). Figure 7 reproduces the relevant graphs in those papers.[242] Thus, an extrapolation of the saturation factor likely will produce reasonable results.

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[241] With no record support for a gap factor of 1.3, it appears that Southern Company chose the gap factor arbitrarily. In this example, OSHA has chosen an equally arbitrary gap factor simply to show how the curves can be manipulated.

[242] This graph is Figure 1 in Ex. 0556 and Figure 2 in Ex. 0558.

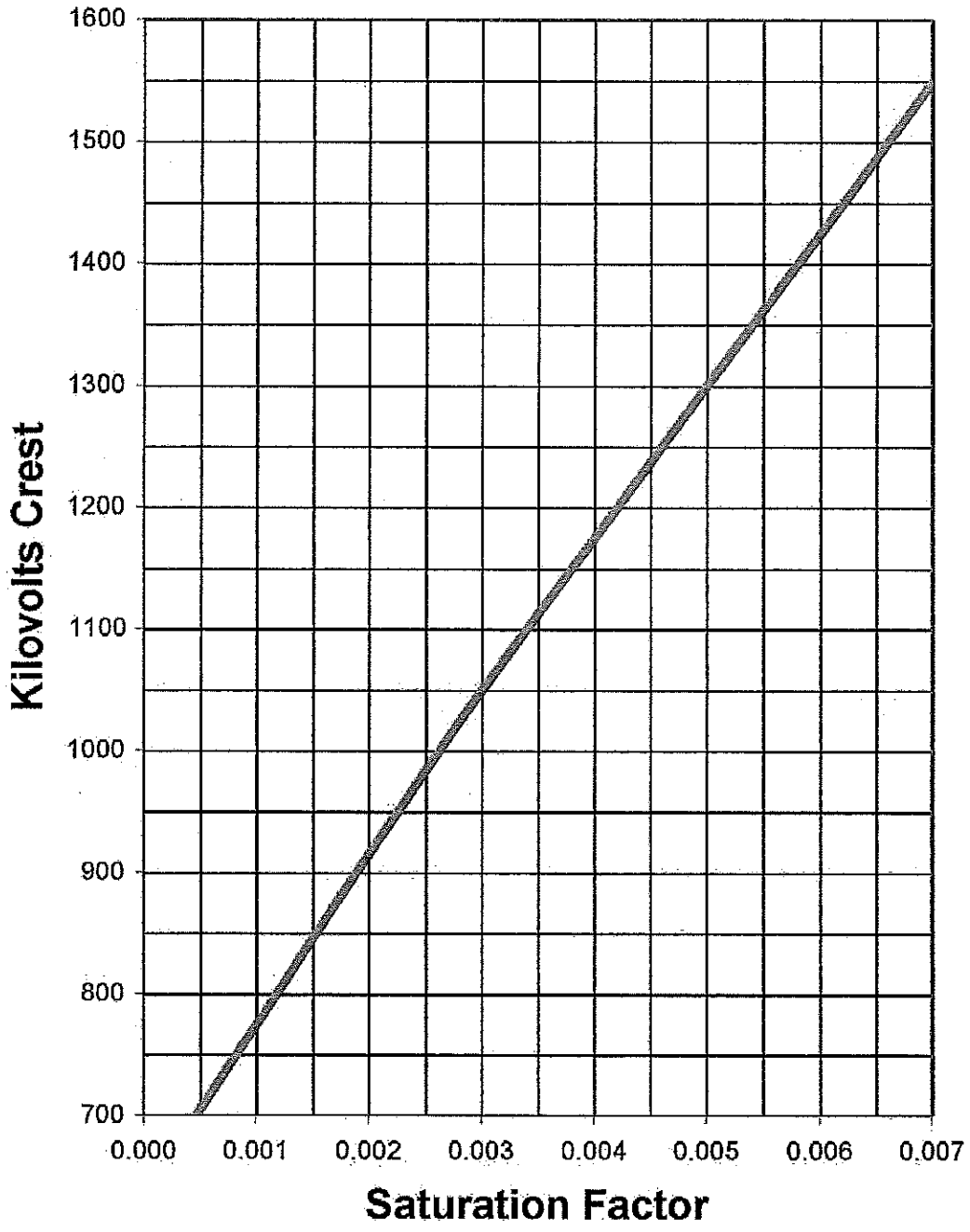

Figure 7—Saturation Factor vs. Voltage

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In addition, as noted earlier, the Gallet and CRIEPI formulas, the other two formulas described by Southern Company for determining sparkover voltages, have a similar shape. (See Figure 6.) The extrapolation method might not be as conservative at the highest voltages as the Gallet and CRIEPI formulas. However, because the modified Gallet and CREIPI formulas rely on a gap factor that is unsupported on the record, and because the gap factor adopted in IEEE Std 516–2009 yields minimum approach distances that are less conservative than the extrapolation method, the Agency believes that the extrapolation method will provide adequate protection for workers. For these reasons, OSHA concludes that it is reasonable to extrapolate the test data to determine minimum approach distances. Consequently, the final rule adopts the extrapolation method of determining minimum approach distances by providing equations for calculating the saturation factor, *a*, as described in the following paragraphs.

Drafts 9 and 10 of the 2009 revision of IEEE Std 516, as well as the approved edition of that standard, provided linear equations for the saturation factor. These equations varied depending on the voltage range (Exs. 0524, 0525, 0532). IEEE Std 516–2009 limits the

equation for the highest range to transient overvoltages of 1,600 kilovolts (Ex. 0532).[243] Drafts 9 and 10 of the 2009 revision of that IEEE standard extrapolated the saturation factor by applying the equation for the highest voltage range without limit (Exs. 0524, 0525). OSHA notes that Drafts 9 and 10 of IEEE Std 516 used slightly different equations for the calculation of the saturation factor than does IEEE Std 516–2009 (Exs. 0524, 0525, 0532). The Agency compared the results of the two sets of equations with the data from the original IEEE reports on which Equation (1) is based and determined that the equations from IEEE Std 516–2009 fit the data precisely. However, IEEE Std 516–2009 notes:

> [T]here is a different value of the "a" [saturation] factor for same voltage used to calculate MAID and MTID. To avoid having values of the "a" factors for MAID and MTID, the working group decided to use only the MTID "a" factor since it matches the values of the "a" factor shown on the figure. [Ex. 0532]

Thus, the IEEE standard bases the saturation factor on the withstand voltages with tools in the gap. OSHA believes that this approach is appropriate for phase-to-ground exposures. However, for phase-to-phase exposures, which almost never involve tools across the gap, the Agency believes that this approach is unnecessarily conservative. Draft 9 of the IEEE standard uses equations for the saturation factor based on test data for air gaps without tools. Therefore, the final rule bases the saturation factor on: (1) The equations from IEEE Std 516–2009 for phase-to-ground exposures and (2) the equations in Draft 9 of that standard for phase-to-phase exposures. Therefore, Table V–2 applies the equations for the saturation factor, *a*, from IEEE Std 516–2009 to phase-to-ground exposures, while using the equations for this factor from Draft 9 of that standard for phase-to-phase exposures. To extrapolate the saturation factor to the highest voltage addressed by the final rule, OSHA is extending the application limit of Equation 59 from IEEE Std 516–2009. The Agency based these equations on the assumption that no insulated tool or large conductive object are in the gap. Note 3 to Table V–2 indicates that, if an insulated tool spans the gap or if a large conductive object is in the gap, employers are to use the equations for phase-to-ground exposures (with V_{Peak} for phase-to-phase exposures).

Circuits operating at 362.1 to 420 kilovolts. In the 2009 reopening notice, OSHA noted that IEEE Std 516–2009 included an additional voltage range, 362.1 to 420 kilovolts, in its minimum approach distance tables; this range did not appear in OSHA's proposed rule (74 FR 46962). The Agency requested comments on whether it should add this voltage range to the minimum approach tables in the final rule. Rulemaking participants recommended adding this voltage range to the OSHA standard, though no electric utilities responding to the issue operated any system in this voltage range. (See, for example, Exs. 0545.1, 0548.1, 0551.1; Tr2. 93, 159.) Dr. Randy Horton, testifying on behalf of EEI, stated:

> OSHA should include these voltage ranges in the final [r]ule in order to provide complete guidance to the industry. However, there are not many lines that operate at these voltages within the American electric utility industry. [Tr2. 93]

Although it appears that there are few, if any, electric power transmission systems in the United States operating at 362.1 to 420 kilovolts, OSHA is including this voltage range in the final standard. Otherwise, an employer with a system operating in this voltage range would have to set minimum approach distances based on a maximum system voltage of 550 kilovolts, the highest voltage in the next higher voltage range listed in Table V–6. Even if systems operating in the 362.1- to 420-kilovolt range are extremely rare, OSHA is not requiring employers to adhere to minimum approach distances that are substantially higher than necessary to protect employees doing work at those voltages. Therefore, OSHA decided to include the 362.1- to 420-kilovolt range in Table V–6 in the final rule, which specifies alternative minimum approach distances for worksites at an elevation of 900 meters or less. Employers not using that table can establish minimum approach distances for any particular voltage, including voltages in the 362.1- to 420-kilovolt range, using the equations in Table V–2 for the maximum voltage on the particular circuit involved.

The electrical component of MAD—DC exposures. OSHA proposed minimum approach distances for dc circuits in Table V–5. OSHA received no comments on these minimum approach distances and, therefore, is adopting them in Table V–7 of the final rule as proposed.

OSHA's requirements on minimum approach distances better effectuate the purpose of the OSH Act than the national consensus standard. Whenever a final rule differs substantially from an existing national consensus standard, Section 6(b)(8) of the OSH Act requires OSHA to publish a statement of reasons in the **Federal Register** explaining why the final rule will better effectuate the purposes of the Act than the national consensus standard. This final rule contains requirements for minimum approach distances that differ substantially from those in the 2012 NESC, which the Agency determined is the current, relevant national consensus standard.

Paragraph (g) of § 1910.2 defines "national consensus standard". There are currently two existing consensus standards addressing minimum approach distances for electric power generation, transmission, and distribution work: ANSI/IEEE C2–2012 and IEEE Std 516–2009. The 2012 NESC, which also is an IEEE standard, was approved as an ANSI standard on June 3, 2011.[244] IEEE Std 516–2009 is not currently an ANSI standard, although the 2003 edition was an ANSI standard.[245] Many States adopt the NESC (Tr2. 151).[246] Mr. Charles Kelly of EEI called the NESC "the preeminent National Consensus Standard on clearance distances for electric utility work on high voltage lines and equipment" (Tr2. 73). Mr. James Tomaseski, testifying on behalf of the NESC, called that document "the authority on safety requirements for power . . . systems" (Tr2. 35). In contrast, rulemaking participants characterized IEEE Std 516 as "an engineering document" containing engineering principles and guidelines

[243] It should be noted that, despite the 1,600-kilovolt limitation, IEEE Std 516–2009 apparently applies this equation to 1,633 kilovolts (the maximum transient overvoltage on an 800-kilovolt system with a 2.5 per-unit maximum transient overvoltage) in the minimum approach distance tables in Appendix D of that standard.

[244] IEEE is the secretariat of the National Electrical Safety Code, which IEEE adopted and which ANSI approved subsequently as a standard. The official designation of the current version of the National Electrical Safety Code is ANSI/IEEE C2–2012. Standards approved as ANSI standards are American National Standards. In addition, the ANSI approval process ensures that procedures used to adopt standards conform to the procedures described in the definition of "national consensus standard" in 29 CFR 1910.2(g). See, for example, OSHA's adoption of national consensus standards and established Federal standards under Section 6(a) of the OSH Act (36 FR 10466, May 29, 1971).

[245] IEEE standards frequently undergo the ANSI approval process. After becoming an approved American National Standard, an IEEE standard shares a joint ANSI/IEEE designation.

[246] According to a survey conducted by IEEE, over 20 States adopted the 2007 edition of the NESC, and several other States adopted other editions of the NESC (*http://standards.ieee.org/about/nesc/pucsurvey2007.pdf*). The States generally enforce public safety provisions of the NESC through public utility commissions. OSHA is not aware of any States that adopted the updated consensus standard since its most recent publication. OSHA anticipates that States will adopt this edition of the NESC when they update their regulations.

(Tr2. 56; see also, for example, Tr2. 59, 74, 129–130, 174). However, the NESC takes those engineering principles and produces work rules, taking into account the practical effects of the requirements. (See, for example, Tr2. 57, 73, 175–176.) OSHA, therefore, concludes that the 2012 NESC is the existing national consensus standard for the purposes of Section 6(b)(8).

The 2012 NESC sets its basic ac minimum approach distances in Table 441–1. This table divides minimum approach distances into two sets of distances: one for voltages up to 72.5 kilovolts and the other for voltages of 72.6 to 800 kilovolts. The minimum approach distances applying to voltages of 72.5 kilovolts and less are the same for work with and without tools between the employee and the energized part. The minimum approach distances applying to voltages of 72.6 to 800 kilovolts vary depending on whether a tool spans the distance between the employee and the energized part. The distances in Table 441–1 are identical to the minimum approach distances in IEEE Std 516–2009 for industry-accepted values of maximum transient overvoltage, and the NESC limits the application of Table 441–1 to situations in which IEEE Std 516–2009 declares that industry-accepted values of maximum transient overvoltage are valid, as described earlier in this section of the preamble.

Table 441–1 in the 2012 NESC does not specify distances for phase-to-phase exposures with tools or large conductive objects between the employee and the energized part. In addition, the table applies only to worksites at an elevation below 900 meters (3,000 feet). For higher elevations, the 2012 NESC requires the employer to calculate minimum approach distances using a formula equivalent to that in IEEE Std 516–2009.

The 2012 NESC requires the employer to make an engineering analysis to determine the minimum approach distance in two situations: (1) If the employer uses phase-to-phase live line tools between the employee and the energized part (Table 441–1, Note 8), and (2) if the employer chooses to use an engineering analysis in lieu of using Table 441–1 (Rule 441A1). A note in the 2012 NESC reads: "IEEE Std 516–2009 contains information that may be used to perform an engineering analysis to determine minimum approach distances."

The 2012 NESC bases its minimum approach distances on IEEE Std 516–2009; and, as explained previously, the Agency concluded that the minimum approach distances in IEEE Std 516–2009 expose employees to additional risk of injury for various exposures. The IEEE standard sets minimum approach distances for exposures at voltages of 72.5 kilovolts and less that do not take account of tools or conductive objects in the air gap. Consequently, OSHA determined that, for these voltages, the IEEE method for calculating minimum approach distances, on which the 2012 NESC bases its minimum approach distances, does not protect employees as well as the method for calculating minimum approach distances specified in the final rule. The final rule ensures adequate employee protection, even when tools or conductive objects are present in the air gap. In addition, for phase-to-phase exposures at voltages of more than 72.5 kilovolts, the Agency found that the method for calculating minimum approach distances in IEEE Std 516–2009, on which the 2012 NESC bases its minimum approach distances, does not use gap factors that adequately represent the full range of employee exposures. Furthermore, the 2012 NESC permits employers to use the industry-accepted values for the maximum per-unit transient overvoltage without ensuring that the maximum transient overvoltages at the worksite cannot exceed those values. Although the 2012 NESC limits the use of the industry-accepted values in some situations, the limitation does not appear to apply to circuits such as the BPA circuit that exhibited higher maximum per-unit transient overvoltages. Thus, OSHA concludes that the 2012 NESC is not as effective as the final rule in protecting employees against high maximum transient overvoltages. Because the minimum approach distances contained in the final rule will better protect employees than the distances specified in the NESC, the Agency also concludes that the final rule will better effectuate the purposes of the OSH Act than the NESC. Therefore, the Agency concludes that the minimum approach distances required by the final rule, which account for actual workplace conditions, will better protect employees than the IEEE distances for these exposures.

Impacts of changes in minimum approach distances. The final rule at § 1926.950(d)(2), as well as § 1926.960(c)(1)(ii) and Table V–2, requires employers to determine the maximum per-unit transient overvoltage for the systems on which employees will be working. Existing § 1910.269(a)(3) already contains a comparable provision, requiring employers to determine existing conditions related to the safety of the work to be performed, including maximum switching transient voltages.

The maximum per-unit transient overvoltages addressed by the existing standard are the industry-accepted values of 3.0 for voltages up to 362 kilovolts, 2.4 for 552 kilovolts, and 2.0 for 800 kilovolts. OSHA believes that, under the existing rule, most employers simply assume these maximum per-unit transient overvoltages and set minimum approach distances accordingly. As explained earlier, this final rule raises the highest maximum transient overvoltages to 3.5 for up to 420 kilovolts, 3.0 for 550 kilovolts, and 2.5 for 800 kilovolts. OSHA believes that some systems will accommodate the larger minimum approach distances that will result from using these new, default values. Not all systems will accommodate such changes, however. (See, for example, Exs. 0573.1, 0575.1, 0577.1.) For phase-to-ground exposures, the minimum approach distance could be as much as 2.35 meters (7.67 feet) greater under the final rule than under Table R–6 in existing § 1910.269. The existing minimum approach distance is 4.53 meters (14.9 feet) for phase-to-ground exposures on an 800-kilovolt system. The final rule sets 6.88 meters (22.57 feet) as the largest minimum approach distance for this voltage. (This increase is due to the use of minimum tool distances, as well as the higher default maximum per-unit transient overvoltage.) Consequently, OSHA believes that employers with installations that will not accommodate these larger minimum approach distances will either determine through engineering analysis or establish through the use of portable protective gaps [247] precise maximum per-unit transient overvoltages on these installations so that the installations will accommodate the required minimum approach distances.

For the systems that exhibit transient overvoltages that will not accommodate the resultant minimum approach distances, OSHA concludes that it is feasible for employers to either control the maximum transient overvoltages, through the implementation of such measures as portable protective gaps, circuit alterations, or operational controls (including blocking reclosing and restricting circuit switching), or deenergize the circuit to perform the work. (See, for example, Exs. 0532, 0548.1; Tr2. 114–115.)

[247] A portable protective gap is a device installed on a phase conductor to provide a known withstand voltage. The gap is designed to spark over at a low enough transient overvoltage to prevent sparkover at the (reduced) electrical component of the minimum approach distance at the work location (Ex. 0532).

The final economic analysis, in Section VI, Final Economic Analysis and Regulatory Flexibility Analysis, later in this preamble, assumes that electric utilities with circuits operating at 230 kilovolts or more (including all circuits in the 169.1- to 242.0-kilovolt voltage range [248]) will be affected by increases in minimum approach distances at those voltages. Therefore, the Agency estimates that 10 percent of the circuits operating at 230 kilovolts or more will require additional measures, such as installing portable protective gaps, that permit employers to adopt minimum approach distances that their circuits can accommodate.[249] However, OSHA is not including any costs for retrofitting or redesigning circuits or equipment for this purpose. The Agency believes that such measures will be rare and undertaken only when they are less costly than the alternatives or when necessitated for reasons unrelated to requirements in the final rule. OSHA did not include cost estimates for taking outages because the Agency concludes that only rarely will other, less costly, measures be impractical.

Several rulemaking participants maintained that adopting minimum approach distances greater than the distances in existing § 1910.269 would have a substantial effect on how employees perform energized line work and possibly on whether they could perform it at all. (See, for example, Exs. 0545.1, 0549.1, 0550.1, 0573.1, 0575.1; Tr2. 53–55, 96–98.) Some of these comments related to climbing structures, with the commenters claiming that employees would be precluded from climbing some structures if the final rule substantially increased minimum approach distances. (See, for example, Exs. 0549.1, 0573.1; Tr2. 54–55, 166.) For instance, Consolidated Edison reported that larger minimum approach distances could prevent workers from climbing towers on several of its lines and noted that clearances vary from tower to tower (Ex. 0549.1). Consolidated Edison also maintained that larger minimum approach distances might prohibit it from positioning an employee on the tower with a live-line tool to perform tasks such as installing cotter keys or removing debris (*id.*). EEI argued that, if minimum approach distances exceeded the length of line insulators, employees would not be permitted to use existing live-line maintenance equipment without changing their work methods (Ex. 0545.1; Tr2. 114–115). EEI and Consolidated Edison, among others, maintained that larger minimum approach distances could increase the number of outages. (See, for example, Exs. 0545.1, 0549.1.)

For each of the examples the commenters provided of situations in which higher minimum approach distances might be problematic, the worker would be at ground potential while located on a tower or other structure. Thus, these comments relate solely to phase-to-ground exposures. For these exposures, the final rule increases minimum approach distances substantially under two conditions: (1) When the maximum per-unit transient overvoltage exceeds the default maximums under the existing standards,[250] or (2) when insulating tools or conductive objects are present in the air gap. In each case, the employer can implement measures, such as using a portable protective gap, to reduce the maximum per-unit transient overvoltage and, consequently, the minimum approach distance. (See Appendix B to final Subpart V for a discussion of the use of a portable protective gap to reduce the required minimum approach distance. Appendix B to existing § 1910.269 recognizes this method of reducing the required minimum approach distance.) In addition, when the employer can demonstrate that there will be only air between the employee and the energized part, which should normally be the case during climbing or inspection procedures, Table V–2 permits the employer to determine minimum approach distances using the equation based on minimum air-insulation distances, which will produce smaller minimum approach distances than the equation based on minimum tool-insulation distance.

Some rulemaking participants maintained that revised minimum approach distances would result in costs related to the purchase of new tools, revision of training programs, and retraining of employees. (See, for example, Exs. 0545.1, 0548.1, 0550.1, 0551.1; Tr2. 94–95.) For instance, American Electric Power commented:

> The potential [cost impact] could be significant, especially when considering the proposed changes and resulting implications on the design standards. It is sufficient to state that changes in minimum approach distances, that exceed the length of standard line insulation, could require the re-tooling of live line maintenance equipment (placing some live line maintenance currently done on hold until new tooling is available); the development of new work methods and the training/re-education that could be required; and could impact current design standards (that are relatively common across the industry). In some cases, on [extra-high-voltage] lines, it is not possible to state that new tooling and procedures can be established until maintenance experts have had adequate time to fully evaluate the situation. [Ex. 0550.1]

OSHA included the costs of training employees in the requirements of the standard, including the minimum approach-distance requirements, in the economic analysis conducted for the proposed rule. (See 70 FR 34905–34910.) The proposal included revised minimum approach distances that were in some cases greater than the distances specified in existing § 1910.269. OSHA's estimates for the proposed rule already accounted for the costs associated with training employees in the revised minimum approach distances, including any necessary changes in procedures. Therefore, the Agency concludes that it is not necessary to increase those cost estimates as a result of the changes made to the minimum approach-distance provisions between the proposed and final rules.[251]

Table 9 shows the differences between the default minimum approach distances in existing § 1910.269 and the final rule for phase-to-ground and phase-to-phase exposures on circuits operating between 72.6 kilovolts and 169.0 kilovolts. This table compares the minimum approach distances in Table R–6 in existing § 1910.269 with the largest minimum approach distances in Table 7 through Table 9 in Appendix B to final Subpart V. The distances in the tables in the appendix assume that an insulated tool spans the gap (or that a

[248] As seen from Table R–6 in existing § 1910.269 and Table V–1 in existing § 1926.950, existing electric power circuits operate at 161 to 169 kilovolts and at 230 to 242 kilovolts. OSHA broadened the ranges in the corresponding tables in the final rule in the unlikely event that electric utilities design and install circuits operating at voltage between the listed voltage ranges.

[249] The final economic analysis estimates that 10 percent of the "projects" (as that term is used in Section VI, Final Economic Analysis and Regulatory Flexibility Analysis, later in this preamble) performed by employers with circuits operating at 230 kilovolts or more will involve installing portable protective gaps based on the assumption that projects are distributed proportionately across affected and unaffected circuits. Consequently, if 10 percent of the circuits operating at voltages of 230 kilovolts or more require "additional measures, such as installing portable protective gaps," then 10 percent of the projects on those circuits will require such measures.

[250] The maximum per-unit transient overvoltages under existing § 1910.269 are 3.0 for voltages up to 362 kilovolts, 2.4 for 552 kilovolts, and 2.0 for 800 kilovolts.

[251] OSHA addressed the cost of retrofitting or redesigning circuits or equipment earlier in this discussion. OSHA's conclusion regarding these costs apply equally to American Electric Power's comment regarding the need to purchase new live-line maintenance equipment.

large conductive object is in the gap) for phase-to-ground exposures.

TABLE 9—INCREASES IN MINIMUM APPROACH DISTANCES FOR PHASE-TO-GROUND EXPOSURES FROM EXISTING § 1910.269 TO FINAL SUBPART V

Voltage kV	Phase-to-ground increase m (ft)	Phase-to-phase increase m (ft)
72.6 to 121.0	0.18 (0.59)	0.13 (0.43)
121.1 to 145.0	0.21 (0.69)	0.14 (0.46)
145.1 to 169.0	0.24 (0.79)	0.23 (0.75)

For these voltage ranges, the maximum difference is no more than 0.24 meters (9 inches). As photographs of live-line tool work in the record show, at these voltages, employers can comply with the minimum approach distances specified in the final rule by having employees make small adjustments in their working positions (269-Ex. 8–5). For example, employees using live-line tools can take a position slightly lower on the pole or structure and maintain the revised minimum approach distances. (As noted previously, when employees work where the employer can demonstrate that no insulated tool spans the gap and that no large conductive object is in the gap, such as during climbing or inspection activities, the final rule sets minimum approach distances for phase-to-ground exposures that are substantially smaller than the minimum approach distances for working with tools; and the maximum difference between the existing and the new minimum approach distance is no more than 0.14 meters (5.5 inches). Information in the record indicates that, as long as OSHA does not apply minimum approach distances to climbing and similar activities based on tools in the gap, employers should be able to comply with the minimum approach distances required by the final rule for those activities without adopting additional measures (Ex. 0575.1[252]).) Because employers generally should be able to demonstrate that no insulated tool spans the gap and that no large conductive object is in the gap during climbing and inspection activities and because the increases in minimum approach distances for voltages of 72.6 to 169.0 kilovolts are small, OSHA believes that, with regard to circuits operating at those voltages, employers will not incur significant costs beyond costs associated with retraining employees, which OSHA included in its economic analysis.

Explanation of the final minimum approach-distance requirements. As noted earlier in this section of the preamble, final § 1926.960(c)(1) specifies minimum approach distances. The proposed rule would have required the employer to ensure that no employee approached or took any conductive object closer to exposed energized parts than the minimum approach distances in proposed Tables V–2 through V–6. The final rule splits this requirement into two provisions. First, as noted previously, paragraph (c)(1)(i) requires employers to establish minimum approach distances no less than the distances computed by Table V–2 for ac systems or Table V–7 for dc systems; OSHA described and explained earlier in this section of the preamble the equations in Table V–2 of the final rule. Second, paragraph (c)(1)(iii) of the final rule requires the employer to ensure that no employee approaches, or takes any conductive object, closer to exposed energized parts than the employer's established minimum approach distances, unless the employee works in accordance with paragraphs (c)(1)(iii)(A), (c)(1)(iii)(B), or (c)(1)(iii)(C). (See the discussion of these alternative methods later in this section of the preamble.)

Paragraph (c)(1)(iii) in the final rule is equivalent to proposed paragraph (c)(1), except that it is the employer that is establishing the specific minimum approach distances for the workplace, based on equations in the standard, rather than the standard setting those distances explicitly.

The proposed rule would have allowed employees to approach energized parts closer than the minimum approach distance under certain conditions (see proposed § 1926.960(c)(1)(i) through (c)(1)(iii)). Existing § 1926.950(c)(1)(i), which is similar to proposed § 1926.960(c)(1)(i), permits the employee to be insulated or guarded from the live parts. OSHA omitted from the proposal language in the existing standard specifically recognizing guarding. However, the language proposed in paragraph (c)(1) required employees to maintain minimum approach distances from "exposed" energized parts. OSHA defines "exposed" in final § 1926.968 as "[n]ot isolated or guarded"; therefore, the minimum approach-distance requirement does not cover guarded live parts, whether guarded by enclosures or barriers or guarded by position (isolated), because they are not "exposed." OSHA removed similar redundancies throughout proposed paragraphs (c)(1)(i) through (c)(1)(iii).

Farmers Rural Electric Cooperative Corporation (FRECC) urged OSHA to retain the language that explicitly recognizes that employees do not have to maintain minimum approach distances from guarded or isolated energized parts (Ex. 0173).

Including language exempting guarded or isolated live parts would be redundant and could lead to misinterpretation of the rule by implying that "exposed energized parts" has a meaning other than not guarded or isolated. Consequently, OSHA did not change the relevant language in this final rule in response to FRECC's comment, and the final rule removes the redundancies as proposed.

OSHA proposed a note to paragraph (c)(1) reading as follows:

[252] In this exhibit, EEI described how applying "MAD for tools" to climbing and inspection activities would make some of this work infeasible. According to EEI, up to 23 percent of line insulators at transmission voltages are shorter than minimum approach distances based on tools in the gap. As explained previously in this section of the preamble, when the employer can demonstrate that there will be only air between the employee and the energized part, which normally should be the case during climbing or inspection procedures, Table V–2 permits the employer to determine minimum approach distances using the equation based on minimum air-insulation distances, which will produce smaller minimum approach distances than the equation based on minimum tool-insulation distance. Therefore, OSHA concludes, the percentage of structures that workers could not climb or inspect without violating the default minimum approach distances in the final rule is significantly smaller than 23 percent for voltages up to 169.0 kilovolts and that, up to this voltage level, any costs related to complying with the final rule's minimum approach distances applicable to climbing or inspecting a structure (such as performing an engineering analysis) are negligible.

Paragraph (f)(1) of § 1926.966 contains requirements for the guarding and isolation of live parts. Parts of electric circuits that meet these two provisions are not considered as "exposed" unless a guard is removed or an employee enters the space intended to provide isolation from the live parts.

Final § 1926.966(f)(1) requires the employer to 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. This provision, which applies to substations, requires guards or isolation for all live parts operating at more than 150 volts to ground unless the live parts have an insulating covering. As explained previously, "exposed" means "[n]ot isolated or guarded," and live parts that are insulated, but not guarded or isolated, are exposed. Thus, live parts operating at more than 150 volts with an insulating covering meet final § 1926.966(f)(1), but are still exposed. Therefore, the proposed note to § 1926.960(c)(1) inaccurately portrays insulated parts as not exposed, and OSHA did not include the note in the final rule.

Proposed paragraph (c)(1)(i) contained the first exception to maintaining the minimum approach distances—insulating the employee from the energized part. This insulation, for example, can take the form of rubber insulating gloves and rubber insulating sleeves. This equipment protects employees from electric shock while they work on energized lines or equipment. Even though uninsulated parts of an employee's body may come closer to the live part being worked on than the minimum approach distance, the requisite rubber insulating gloves and sleeves would insulate the employee's hand and arm from the live part, and the working distances involved would be sufficient protection against arc-over. As noted earlier, the minimum approach distances include a component for inadvertent movement, which is unnecessary for employees using rubber insulating equipment. Such inadvertent movement most often involved the employee's hands and arms, and the insulating equipment will protect them. In addition, the employee has control over the energized part. The accident data in the record show that the overriding hazard to employees involves other energized conductors in the work area, to which the minimum approach distances still apply. Final paragraph (c)(1)(iii)(A) provides that employees may use insulating gloves and sleeves to insulate themselves from the energized parts upon which they are working; rubber insulating gloves and sleeves provide protection only for the line on which the employee is performing work. Employers must ensure that employees maintain the required minimum approach distances from other exposed energized parts. In addition, the insulation used must be designed for the voltage. (Final § 1926.97 gives use voltages for electrical protective equipment.)

IBEW recommended that OSHA clarify the final rule to indicate that rubber insulating gloves or rubber insulating gloves with sleeves provide adequate protection *"only* from the energized part upon which the employee is working, *not to other energized parts in the work area"* (Ex. 0230; emphasis included in original). OSHA is not adopting IBEW's suggestion. Although this language correctly represents the meaning of the provision, the Agency believes that this meaning is clear without the suggested changes.

It is important to ensure that conductors on which the employee is working cannot move unexpectedly while only rubber insulating gloves and sleeves are protecting the employee against contact with the conductors. It is a violation of the minimum approach-distance requirement contained in existing § 1910.269(l)(2)(i) for an employee to be insulated from an energized part only by rubber insulating gloves and sleeves if the part is not under the full control of the employee at all times. For example, if an employee is cutting a conductor, the employee must restrain the conductor from moving toward the employee after being cut, or the employee must use additional insulation to prevent the conductor from striking uninsulated parts of his or her body. OSHA proposed to make this requirement explicit in parenthetical text in the proposed rule, including in the proposed revision of § 1910.269.

Two commenters objected to the proposed language requiring the employee to have control of the energized part sufficient to prevent exposure to uninsulated parts of the employee's body (Exs. 0201, 0209). They claimed that it is not always possible for the employer to ensure that an employee has adequate control over a part. For example, Mr. James Gartland with Duke Energy commented:

> OSHA should require employees to maintain control of energized parts only when it is reasonably achievable. It is not always possible. . . . The revised text . . . should be: ". . .provided that the employee has control of the part *insofar as possible* to prevent exposure to uninsulated parts of the body." [Ex. 0201; emphasis in original.]

The Agency is not adopting this recommendation. The language does not require employees to maintain control of energized parts under all conditions. The provision requires additional insulation on the energized part when the employee does not have sufficient control to prevent contact with uninsulated parts of his or her body. When it is not possible for the employee to maintain sufficient control, the final rule provides several options: (1) Maintain the minimum approach distance (per the introductory text to final paragraph (c)(1)(iii)); (2) insulate the employee by installing an insulating barrier, such as a rubber insulating blanket, between the employee and the energized part (per final paragraph (c)(1)(iii)(A)); or (3) install a rubber insulating line hose or a rubber insulating blanket on the energized part (per final paragraph (c)(1)(iii)(B)). Allowing the employee to work on an energized part that is not under the employee's full control, with rubber insulating gloves and sleeves as the only insulating barrier from the energized part, would not protect employees sufficiently.

The Ohio Rural Electric Cooperatives requested clarification of what the Agency would consider to be adequate control, suggesting that several types of measures might be adequate, including tying a conductor to an insulator, clipping a conductor into the holder on the jib arm of an aerial lift, and holding the conductor by hand at the edge of the bucket of an aerial lift (Ex. 0186).

OSHA would generally consider any of these measures to constitute adequate control. Using a mechanical device, such as a tie wire or live-line tool clamps, would adequately control the end of an energized conductor as long as it is of adequate strength for the application. However, the employer also must consider portions of the conductor not under the control of a mechanical device. For example, when the employee takes the slack from a conductor under tension and must cut the conductor to remove any excess, the employer must consider whether the conductor, now held in place by the tensioning equipment, will break from the employee's control after it is cut. OSHA would consider a conductor held by an employee to generally be under adequate control. However, if the conductor is hanging down and is not under the employee's full control, the employer must ensure that the employee is protected from exposure to

the lower portion of the conductor that could come too close to his or her leg.

Mr. Leo Muckerheide with Safety Consulting Services objected to the description of the application of minimum approach distances to employees wearing rubber insulating gloves provided in the preamble to the proposal (Ex. 0180). He assumed that existing Subpart V and the proposal, which use similar language, did not permit uninsulated portions of the employee's body to come closer to energized parts than the minimum approach distance, even when the employee was wearing rubber insulating gloves. In one particular example, he commented:

> [T]he minimum distance listed in existing table V–1 for 2100 volts is 24 inches and the maximum length of an insulated glove is 18 inches. Therefore, it would be impossible to work on energized circuits with only insulating gloves and be in compliance with the existing table V–1. [*id.*]

Mr. Muckerheide misinterpreted this provision. The final standard clearly considers the whole employee insulated as long as rated rubber insulating gloves or gloves with sleeves insulate his or her hands and arms.

The Agency determined that the language explaining when rubber insulating gloves or rubber insulating gloves with sleeves are adequate protection is necessary and appropriate and has adopted it without substantial change in the final rule. (The final rule adds the word "rubber" to the term "insulating gloves or insulating gloves and sleeves." "Rubber insulating gloves" and "rubber insulating sleeves" are the precise terms used to describe this equipment, and this revision clarifies that final §§ 1910.137 and 1926.97 cover this equipment.)

As a second exception to maintaining the minimum approach distances, paragraph (c)(1)(iii)(B), which OSHA adopted without change from proposed paragraph (c)(1)(ii), allows the energized part to be insulated from the employee and any other conductive object at a different potential. Such insulation can be in the form of rubber insulating blankets or line hose or other suitable insulating equipment. Again, the insulation must be adequate for the voltage.

Paragraphs (c)(1)(iii)(A) and (c)(1)(iii)(B) in the final rule recognize the protection afforded to the employee by an insulating barrier between the employee and the energized part. As long as the insulation is appropriate and is in good condition, current will not flow through the worker, thereby protecting the worker.

The third exception to the requirement to maintain minimum approach distances (final paragraph (c)(1)(iii)(C)) is for live-line barehand work. (For specific practices for this type of work, see the discussion of final § 1926.964(c) later in this preamble.) In this type of work, the employee is in contact with the energized line, but is not contacting another conductive object at a different potential. This is the "bird-on-a-wire" scenario. Because there is no complete circuit, current cannot flow through the worker, thereby protecting the worker.

In the proposed rule, the exception for live-line barehand work was broad enough to cover any work in which the employee is insulated from any other exposed conductive objects. However, OSHA knows of several accidents that occurred when employees working from aerial lifts, either insulated or uninsulated, grabbed energized conductors (Ex. 0004[253]). OSHA believes that some employers assume that this practice is safe and, therefore, do not follow the live-line barehand procedures specified in final § 1926.964(c) for live-line barehand work. In the preamble to the proposed rule, OSHA requested comments on whether the proposal would adequately protect employees from this type of accident and on what additional requirements, if any, would prevent this type of accident.

Two commenters responded to this issue; they both believed that the proposed rule would adequately protect employees (Exs. 0126, 0213). Another commenter stated that proper training is necessary to prevent these types of actions (Ex. 0219).

OSHA determined that the requirements for live-line barehand work are necessary whenever employees are working closer than the minimum approach distance in accordance with final paragraph (c)(1)(iii)(C). The accidents in the record make it clear that simply using an insulated aerial lift to isolate employees from energized parts is not sufficient protection (Exs. 0002, 0003, 0004). In Ex. 0004 alone, 69 accidents involved employees in aerial lifts who were working inside the minimum approach distance without sufficient electrical protective equipment. The accident summaries for these accidents indicated that 11 of the accidents involved insulated aerial lifts and that 2 of the accidents involved uninsulated aerial lifts. Because power line work predominantly makes use of insulated aerial devices, the Agency believes that most of the other 56 accidents also involved insulated aerial lifts. Employers may argue that the language in proposed paragraph (c)(1)(iii) permits employees working from insulated aerial lifts to position themselves inside the minimum approach distance without following § 1926.964(c). The sheer number of accidents involving this practice clearly demonstrates that this practice is unsafe. In addition, the 2002 NESC, in Rule 441A1d,[254] contains a similar restriction on its equivalent exception to its minimum approach-distance requirement. Therefore, OSHA concludes that it is necessary to restrict the exception proposed in paragraph (c)(1)(iii) to live-line barehand work performed in accordance with final § 1926.964(c) and modified the language of this exception, which is contained in § 1926.960(c)(1)(iii)(C), accordingly.

According to testimony in the § 1910.269 rulemaking, between five and six percent of accidents experienced by power line workers resulted when the upper arm of an employee wearing rubber insulating gloves without sleeves contacted an energized part (269-DC Tr. 558–561). This is a significant portion of the total number of serious accidents occurring among electric line workers. The Agency believes that most of these injuries and fatalities were preventable had the employees used rubber insulating sleeves. However, as demonstrated by the safety record of some electric utility companies, the extensive use of insulating equipment to cover energized parts in the employee's work area also would appear to prevent employees' upper arms and shoulders from contacting live parts (269-Ex. 46). OSHA believes that insulating every energized part within reach of an employee also would avert electrical contacts involving other parts of the body, such as an employee's head or back.

Existing Subpart V does not require any protection for employees working on or near exposed live parts beyond the use of rubber insulating gloves. To prevent the types of accidents described previously from occurring in the future, the Agency decided to require protection in addition to that required by existing Subpart V.

OSHA adopted paragraph (c)(2)(i) in the final rule substantially as proposed; this provision generally requires employees to use rubber insulating

[253] See, for example, the four accidents described at *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=200550457&id=171055783&id=200780294&id=301171807.*

[254] The 2012 NESC contains a similar provision in Rule 441A1d.

sleeves whenever they are using rubber insulating gloves under final paragraph (c)(1)(iii)(A). However, insulating exposed live parts on which the employee is not working makes the sleeves unnecessary as long as the insulation is placed from a position that would not expose the employee's upper arm to contact with those parts (see final paragraph (c)(2)). Therefore, employees can work without sleeves by installing rubber line hose, rubber blankets, or plastic guard equipment on exposed, energized parts on which the employees are not performing work. OSHA reworded this provision in the final rule for purposes of clarity.

NIOSH recommended that the standard require rubber insulating sleeves whenever employees use rubber insulating gloves (Ex. 0130). NIOSH explained: "[G]loves can be easily caught and pulled down by any object protruding from the pole or powerline, exposing the body to electrical current. . . . [S]leeves add extra protection" (*id.*). NIOSH pointed to one accident in support of its position (Ex. 0137).

OSHA reviewed the accident and found that it involved a situation in which a splice on a conductor pulled down the cuff of the employee's rubber insulating glove, with the conductor then contacting his forearm near the wrist (*id.*). OSHA acknowledges that such accidents occur. For example, there is a description of an additional similar accident in the rulemaking record (Ex. 0002 [255]). Rubber insulating sleeves protect an employee's arm from a point above the cuff of the rubber insulating glove to the shoulder. In the accident cited by NIOSH, as well as the other accident in the record, the conductor contacted the employee at or near the wrist, where rubber insulating sleeves probably would not have protected the employee. OSHA believes that the work practices in which an employer trains qualified employees must include practices designed to protect workers from the possibility that an energized conductor will either pull a cuff down or penetrate the opening at the end of the glove. (Paragraph (b)(1)(ii) of final § 1926.950 requires employers to train each employee in "safety practices . . . 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.") The Agency concludes that such work practices, rather than the use of sleeves, will protect employees from being injured or killed in the circumstances described by NIOSH. Therefore, OSHA is not adopting NIOSH's recommendation in the final rule.

OSHA knows of several accidents that occurred while employees were performing work (generally on deenergized lines) near energized parts without using rubber insulating equipment (Ex. 0004 [256]). In these accidents, the employees were working near energized parts and inadvertently entered the minimum approach distance. Employers successfully challenged citations issued in a similar context by arguing that the standard permits employees to work near energized parts without the use of electrical protective equipment, as long as they maintain the minimum approach distance involved and that, because they trained their employees to maintain those distances, the accidents were the result of unpreventable employee misconduct. (See, for example, *Central Kansas Power Co.*, 6 BNA OSHC 2118 (No. 77–3127, 1978).)

OSHA does not believe that working close to energized parts (that is, near the minimum approach distance boundary) without the use of electrical protective equipment is a safe practice. The Agency further believes that existing § 1910.269, which appears to allow this practice, is not effective in preventing these accidents. Therefore, OSHA concludes that further regulation is necessary. Toward this end, OSHA proposed two new requirements:

(1) If an employee is performing work near exposed parts energized at more than 600 volts but not more than 72.5 kilovolts and is not insulated from the energized parts or performing live-line bare-hand work, the employee would have to work from a position where he or she could not reach into the minimum approach distance (proposed § 1926.960(d)(2)), and

(2) If an employee uses insulating gloves or insulating gloves with sleeves to insulate himself or herself from energized parts, the insulating gloves and sleeves would have to be put on and removed in a position where the employee could not reach into the minimum approach distance (proposed § 1926.960(c)(2)(ii)).

The Agency proposed § 1926.960(c)(2)(ii) to ensure that employees don rubber insulating gloves and sleeves from a safe position. OSHA is aware that some employers have a ground-to-ground rule requiring their employees to wear rubber insulating gloves before leaving the ground to perform work and to leave the gloves on until the employees return to the ground. This practice ensures that employees wear the rubber gloves and sleeves before they reach the energized area and eliminates the chance that an employee will forget to don the protective equipment once he or she reaches the work position. Other employers simply require their employees to put on their gloves and sleeves before they enter the energized area. This practice normally requires the employee to use his or her judgment in determining where to begin wearing the protective equipment. The proposal recognized both methods of protecting employees, but still ensured that employees wear rubber insulating gloves and sleeves once they reach positions from which they can reach into the minimum approach distance. In the preamble to the proposal, the Agency requested comments on the need for this requirement and on whether the provision as proposed would protect employees from the relevant hazards.

Many commenters expressed support for this proposed requirement or urged the Agency to make the rule even more protective. (See, for example, Exs. 0099, 0126, 0130, 0155, 0175, 0186, 0219, 0230, 0505; Tr. 891–894.) In supporting the proposed requirement, Mr. Anthony Ahern with Ohio Rural Electric Cooperatives explained:

> Judging actual distance when in close proximity to a conductor can be tricky. Great care needs to be used when putting on or taking off sleeves when in close proximity to lines. This usually requires the arms to be extended more than the employee might normally do during regular work practices. Quite often too you will see a worker waving his arms about as they try to settle the sleeve harness into position behind their head. These inadvertent movements could bring the workers arms inside of MAD. Also, while sleeves are being put on or taken off the employee is not wearing rubber gloves. So if he should reach inside of MAD his hands will have no protection. [Ex. 0186]

EEI and Ameren Corporation objected to proposed paragraph (c)(2)(ii) because, they argued, it would effectively increase the minimum approach distance (Exs. 0209, 0227, 0501). Ameren argued that "[e]nsuring compliance with this proposal would be extremely difficult, if not impossible," and that there was additional risk for employees climbing with rubber insulating gloves (Ex. 0209). EEI echoed Ameren's objections and maintained that this provision was effectively increasing the ergonomic movement

[255] A report of this accident is available at: *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=573717.*

[256] See, for example, the six accidents described at *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=170074801&id=200010163&id=201750080&id=142420368&id=982082&id=170189849.*

factor of the minimum approach distance (Ex. 0227). EEI maintained that this provision would have a significant adverse impact on industry practices (*id.*). In its posthearing submission after the 2006 hearing, EEI presented additional arguments against the proposed requirement:

> There are several important difficulties with the proposed rules that are self-evident. First, they do not establish an objective standard, and therefore would be unenforceable. The rules would be different for each employee, depending for example on personal height, reach, working position, and the particular configuration of the energized equipment in the vicinity. This will make it difficult to train employees in compliance, and could make supervisory enforcement of the rule a nightmare. Indeed, whether an employee is [in] compliance could change literally from second to second, for example, as the employee shift[s] weight on a pole, or turns around to speak with a co-worker. As a litigation matter, proving the violation element of employer knowledge will be problematic at best.
>
> Second, the rules will effectively limit or inhibit the nature of work that can be performed outside, but within reaching distance, of the MAD. In planning a job, it would be necessary to consider what work is to be performed outside the MAD distance, and to consider the individual physical characteristics of the employee(s) who would perform it. Conceivably, short employees, with short arms, would be favored over tall, lanky employees, with long arms. This makes no sense, and it does not appear that OSHA has considered or analyzed the potential practical implications of these requirements. . . .
>
> Finally, there is no evidence in the record to show why OSHA is proposing to implement these requirements. There is no evidence that in the absence of these particular requirements, employees have been injured or suffered near misses with energized electrical equipment. In sum, these proposals are without any basis, and cannot be sustained. [Ex. 0501]

OSHA does not agree that proposed paragraph (c)(2)(ii) increased the minimum approach distance. Proposed paragraphs (c)(2)(ii) and (d)(2) did not address the question of the employee's location once he or she is wearing rubber insulating gloves and sleeves. Final paragraph (c)(2)(ii) simply ensures that the employee is already wearing the gloves and sleeves before he or she gets into position to perform work. This paragraph has no effect on the minimum approach distances, which provide protection against both energized parts on which the employee will be working and other energized parts in the area. Under final paragraph (c)(1)(iii)(A), once the gloves and sleeves are on, workers may get within the minimum approach distance for the part on which they are performing work. In addition, employees need to maintain the minimum approach distances (not distances greater than the minimum approach distances) for parts on which they are not working.

EEI and Ameren's argument that the provision would be difficult to enforce is specious. The record contains several examples of methods of compliance that would be reasonably easy to enforce, as well as easy for employees to understand and follow. For example, employers can institute ground-to-ground, cradle-to-cradle, or lock-to-lock rules. (See, for example, Exs. 0099, 0130, 0201.) Mr. Kenneth Brubaker described these rules as "the wearing of rubber [insulating] gloves and sleeves from ground to ground while climbing energized structures, from cradle to cradle while working from aerial baskets, and lock to lock when working on underground cabinets and vaults for qualified line personnel" (Exs. 0099, 0100). Commenters also suggested a "10-foot rule" in which employees must wear electrical protective equipment whenever they are within 3.05 meters (10 feet) of an exposed energized part (Exs. 0099, 0186). OSHA expects that employers generally will elect to use bright-line rules (for example, cradle-to-cradle or 3.05-meter rules) such that an individual employee's height and reach will not be an issue. Instituting such rules will ensure that all employees put on and take off rubber insulating gloves and sleeves as specified by the final rule. If an employer elects to use an alternative in which an employee will be putting on and taking off rubber gloves and sleeves in an unspecified location (for example if the employer simply instructs the employee to put on and take off gloves and sleeves at any location outside the reach of the minimum approach distance), the employer will need to account for the employee's individual characteristics.

EEI's argument that planning jobs would be difficult under proposed paragraph (c)(2)(ii) is not relevant. This paragraph only applies when workers use rubber insulating gloves or rubber insulating gloves with sleeves, which the employees have to don and remove. This rule simply addresses donning and removal of this equipment in relation to the energized parts. OSHA addresses EEI's comments further in its discussion of proposed paragraph (d)(2), which addresses selecting work positions.

OSHA concludes that there is clear evidence in the record of fatalities and injuries caused when employees approach too close to energized parts without adequate protection (Exs. 0002, 0003, 0004).[257] Evidence in the record indicates that industry and employee representatives recognize that failure to wear electrical protective equipment when necessary is a leading cause of accidents and that additional measures to ensure the use of this equipment in appropriate circumstances addresses this problem. For example, Mr. James Tomaseski with IBEW testified:

> In a study on recent fatalities and serious accidents in the industry by the OSHA Strategic Partnership of Major Electric Line Contractor Employees, NECA, the IBEW, and EEI, by far the majority of the accidents were from contact with energized parts. A solution was easy in some folks' minds, and that was to come up with a practice to get employees in rubber gloves and/or, again, rubber sleeves, where required.
>
> The Partnership, as part of their agreed-upon path, will develop best practices. Their first target for these best practices was in general to address electrical contacts. It was no surprise to many of the partners that ground-to-ground and cradle-to-cradle practices were first on the list. [Tr. 892]

IBEW also pointed to action taken by NESC Subcommittee 8 as evidence of the need to don and remove rubber insulating gloves and sleeves outside locations in which employees can reach into minimum approach distances (Ex. 0505). According to IBEW's comments, the NESC subcommittee adopted a requirement for the 2007 NESC specifying that rubber insulating gloves be "worn whenever employees are within the reach or extended reach of the minimum approach distances" (*id.*).[258]

In addition, Mr. Ahern's description of the types of movements employees make when donning rubber insulating sleeves makes it clear that the final rule needs measures to ensure that workers do not encroach on the minimum approach distance during such activities. Encroaching on the minimum approach distance to energized parts presents hazards to employees, particularly when involved in tasks not related directly to work on those live parts.[259] Thus, the Agency believes that paragraph (c)(2)(ii), which OSHA is

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[257] See, for example, the 15 accidents described at *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=526236&id=564971&id=566257&id=565051&id=512269&id=525675&id=609404&id=573832&id=743310&id=755231&id=738989&id=755199&id=800508&id=784397&id=812479.*

[258] The NESC adopted this requirement, which, in the 2012 edition, appears in Rule 441A3b.

[259] The ergonomic component of the minimum approach distance only protects against errors in judging and maintaining the minimum approach distance. It does not account for errors that might result when employees become inattentive to the approach distance because of work-related distractions or other factors.

adopting in the final rule with only editorial changes from the proposal, is reasonably necessary and appropriate.[260]

Some rulemaking participants recommended that the final rule include a requirement that employers availing themselves of the exception to the minimum approach-distance requirements for work performed with rubber insulating gloves (or rubber insulating gloves and sleeves) adopt ground-to-ground, cradle-to-cradle, or lock-to-lock rules, or set a specific distance from energized parts at which employees must wear electrical protective equipment.[261] (See, for example, Exs. 0099, 0130, 0186, 0230; Tr. 893–894.) IBEW recommended a cradle-to-cradle requirement (Ex. 0230; Tr. 893–894). Two comments suggested that the rule specify the distance from energized parts at which employees must wear rubber insulating gloves or rubber insulating gloves and sleeves (Exs. 0099, 0186). One of these commenters suggested requiring that employees wear rubber insulating gloves and sleeves within 3.05 meters (10 feet) of circuits energized at 500 volts to 500 kilovolts and within 6.1 meters (20 feet) of circuits energized at 500 to 800 kilovolts (Ex. 0099).

NIOSH recommended adopting a ground-to-ground rule, stating:

> Ground to ground use of personal protective equipment (PPE) eliminates the hazard of reaching the energized area before donning PPE. It also eliminates the reliance on employee judgment in determining a safe distance to don PPE, and requires the worker to don PPE before entering an aerial bucket . . . [Ex. 0130]

Other rulemaking participants opposed ground-to-ground and similarly specific rules (Exs. 0163, 0212, 0225). For example, Ms. Susan O'Connor with Siemens argued that "[f]orcing the use of one type of enforcement strategy, especially one that questions the employee's competency, can undermine a strong safety culture" (Ex. 0163). Mr. James Gartland with Duke Energy did not oppose ground-to-ground and similar rules, but recommended that any such rule include an exception to permit employees, during short breaks, to move 3.05 meters (10 feet) away and to remove their electrical protective equipment (Ex. 0201). He commented that his company "has found the occurrence of heat-related illnesses has been reduced by allowing employees to move the bucket away from the conductors and remove rubber gloves and sleeves for a brief rest period" (*id.*). Although IBEW did not oppose a ground-to-ground rule, the union recognized that there may be valid arguments against such a requirement. Mr. Tomaseski testified:

> There are a few factors that mitigate against requiring [rubber insulating gloves] ground-to-ground in all circumstances. First, some linemen are concerned that they would have difficulty feeling the pole while they are climbing if they had to wear rubber gloves and they, therefore, would be at a greater risk of falling.
>
> Second, if a splinter on the pole [punctures] the glove . . . while [the employee is] climbing, it may compromise the protective value of the glove and, therefore, create a hazard for the lineman who subsequently touches an energized object. [Tr. 893]

In recommending a cradle-to-cradle rule, the union argued that these factors were not present when an employee is working from an aerial lift (Tr. 893–894).

OSHA concludes that there is likely to be little risk associated with wearing rubber insulating gloves while climbing. The practices required by final § 1926.954(b)(3)(iii) should mitigate any fall hazards posed by climbing with rubber insulating gloves; this provision specifies fall protection for employees climbing poles and other structures. The Agency also believes it is unlikely that splinters will puncture rubber insulating gloves during climbing. In this regard, final § 1926.97(c)(2)(vii) requires employees to wear protector gloves over rubber insulating gloves; protector gloves should eliminate any risk from small splinters. The Agency believes that employees would feel any splinter large enough to penetrate the protector gloves and also would notice any resulting damage to a rubber insulating glove. In any event, there is little, if any, evidence that accidents occurred as a result of fall or splinter hazards posed by climbing with rubber insulating gloves.[262] On the other hand, evidence of accidents caused by employees not wearing rubber insulating gloves is pervasive (Exs. 0002, 0003, 0004). As Mr. Tomaseski noted, the electric power partnership found that "by far the majority of the accidents were from contact with energized parts" (Tr. 892).

There is, however, significant evidence, as noted in the summary and explanation for § 1926.960(g) of the final rule later in this section of the preamble, that electric power workers encounter heat-stress hazards and that providing cooling breaks is a recognized method of reducing such hazards. Adopting a ground-to-ground or cradle-to-cradle rule would force employees wearing rubber insulating gloves to either descend and reclimb poles or lower and reraise their aerial lift platforms to take breaks from wearing the protective equipment. The Agency suspects that such a requirement could discourage employees from taking these breaks. Consequently, OSHA is not adopting a ground-to-ground or cradle-to-cradle rule. Although the Agency is not adopting ground-to-ground or cradle-to-cradle provisions in the final rule, OSHA encourages employers to adopt such provisions when appropriate and to remind employees of the importance of taking cooling breaks when necessary.

The Agency also decided not to include in the final rule a specific distance beyond which employees must put on and take off their rubber insulating gloves. Any such distance would be arbitrary, and OSHA believes that allowing employers to design work rules appropriate for their workforces and workplaces is a more reasonable approach. Consequently, OSHA is adopting paragraph (c)(2)(ii) in the final rule substantially as proposed. As explained previously under the summary and explanation for paragraph (c)(1)(iii)(A), the final rule uses the term "rubber insulating gloves" in place of the term "insulating gloves" included in the proposed rule.

Paragraph (d) of the final rule addresses the employee's working position. The requirements in this paragraph protect employees against slipping, falling, or accidentally reaching into energized parts. Mr. Stephen Frost with the Mid-Columbia Utilities Safety Alliance supported proposed paragraph (d), commenting:

> Industry practice and OSHA guidance has always stated that the worker shall not be within reaching or falling distance when working near energized lines or equipment. We appreciate OSHA revising the language to more clearly state what is reaching or falling distance. [Ex. 0184]

Paragraph (d)(1), which is being adopted without substantive change

[260] One commenter noted that OSHA proposed the same requirement in § 1910.269(l)(3)(ii) using slightly different language (Ex. 0186). The final rule uses the same language in both §§ 1910.269(l)(3)(ii) and 1926.960(c)(2)(ii).

[261] A ground-to-ground rule requires employees climbing a pole to put on rubber insulating gloves or rubber insulating gloves with sleeves while still on the ground and to remove them only after returning to the ground. A cradle-to-cradle rule requires employees working from an aerial lift to wear gloves or gloves with sleeves whenever the aerial lift platform leaves its cradle. A lock-to-lock rule requires employees working on transformers to wear gloves or gloves with sleeves from the time they unlock the lock on the transformer until they close the transformer case and reinstall the lock.

[262] The record contains descriptions of several accidents involving falls by employees during climbing, but none of the descriptions indicates that the use of rubber insulating gloves caused the fall.

from the proposal, requires the employer to ensure that each employee, to the extent permitted by other safety-related conditions at the worksite, works in a position from which a shock or slip would not cause the employee to contact exposed, uninsulated parts energized at a potential different from the employee's. Since slips, and even electric shocks, are not entirely preventable, it is important for the employee to take a working position so that such an event will not increase the severity of any incurred injury. OSHA adopted this requirement from existing § 1910.269(l)(4). There is no counterpart to this requirement in existing subpart V.

The Agency believes that it is important for employees to work from positions where a slip or a shock will not bring them into contact with exposed, uninsulated energized parts unless other conditions, such as the configuration of the lines involved, would make another working position safer. The position taken must be the most protective available to accomplish the task. In certain situations, this work position may not be the most efficient one. OSHA notes that the language in paragraph (d)(1) allows for guarding or insulating the live part as an alternative means of compliance.

Proposed paragraph (d)(2) generally would have required an employee working near exposed parts energized at 601 volts to 72.5 kilovolts to be in a position such that he or she could not reach into the applicable minimum approach distance. In the preamble to the proposed rule, OSHA requested comments on the need for proposed paragraph (d)(2) and on whether there are other effective means of protecting employees from the relevant hazard.

The Southern Company argued that "[t]he minimum approach distance contains an ergonomic component that should provide adequate protection from inadvertent movement" (Ex. 0212).

OSHA does not agree with Southern Company that the ergonomic component of the minimum approach distance provides adequate protection for employees who are working close to, but not on, exposed, uninsulated energized parts. As explained earlier in the preamble, OSHA concluded that working extremely close to (that is, near the minimum approach distance boundary to) energized parts without the use of electrical protective equipment is not a safe practice and that existing § 1910.269, which may allow this practice, is not effective in preventing accidents involving contact with energized parts by employees who are not using electrical protective equipment. (See the summary and explanation for final § 1926.960(c)(2)(ii) for a description of the purpose behind paragraphs (c)(2)(ii) and (d)(2) and a discussion of the relevant accidents.)

When employees are not working directly on live parts, then nearby exposed, uninsulated live parts are typically not in their view. Those parts can be above them,[263] below them,[264] behind them,[265] or to the side[266] (Exs 0002, 0003, 0004). As noted previously, OSHA designed the ergonomic component of the minimum approach distance on the premise that the employee will detect an error in judging and maintaining the minimum approach distance and then have time to correct that error before encroaching on the electrical component of the minimum approach distance. When exposed, uninsulated live parts are not in an employee's line of sight, such errors are difficult to detect. In addition, the Agency believes that, when employees are not performing work on energized parts, the employees are not paying as much attention to those parts as to the equipment the employees are servicing and may, inadvertently, become complacent about the hazards posed by those parts. In any event, the accident record makes it clear that employees working without electrical protective equipment near exposed, uninsulated parts energized at 601 volts to 72.5 kilovolts face an unacceptable risk of electric shock.

An alternative approach would be for OSHA to adopt a more limited requirement prohibiting employees without electrical protective equipment from working where they could reach into the electrical component of the minimum approach distance. The basis of such a requirement would be that the probability that current could arc to the employee is not significant at a distance that is farther than the electrical component of the minimum approach distance from exposed, uninsulated live parts. However, as the accident data show, employees often are moving up, back, down, or in other directions away from their working positions when they contact live parts (*id.*).[267] The Agency, therefore, concludes that requiring employees to work in positions from which they cannot reach into the electrical component (rather than the full minimum approach distance) would not protect employees adequately. Existing § 1910.269(a)(2)(ii)(C) already requires employers to train their employees in minimum approach distances. In addition, final § 1926.960(c)(2)(ii) requires employers to ensure that employees using rubber insulating gloves or rubber insulating gloves and sleeves don the gloves and sleeves before they get into a position from which they can reach into the minimum approach distance. OSHA believes that using the same distance for paragraph (d)(2) will simplify training and make it easier for employers to establish work rules governing the use of electrical protective equipment.

In the preamble to the proposed rule, the Agency discussed how to comply with OSHA's minimum approach-distance requirements in the summary and explanation for the proposal's minimum approach distances specified in § 1926.960(c)(1) (70 FR 34862). Although this discussion applies equally to § 1926.960(c)(1) in the final rule, the Agency is moving the discussion to the summary and explanation for final § 1926.960(d)(2) because it relates to both provisions and to comments received on both provisions, which OSHA discusses here. The ergonomic component of the minimum approach distance accounts for errors in maintaining the minimum approach distance (which might occur 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 comply with final paragraph (c)(1)(iii) (and paragraphs (c)(2)(ii) and (d)(2)) must account for all of an employee's reasonably likely movements and still permit the employee to adhere to the applicable minimum approach distance. As noted in the preamble to the proposal (*id.*), and in final Appendix B, to ensure compliance with minimum approach distances (the electrical and ergonomic components combined), the work position selected must account for such reasonably likely movements as:

[263] See, for example, the three accidents described at *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=201520301&id=573832&id=14333439.*

[264] See, for example, the three accidents described at *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=927830&id=839480&id=14373955.*

[265] See, for example, the three accidents described at *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=14403315&id=200350395&id=14346514.*

[266] See, for example, the three accidents described at *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=170672547&id=512269&id=569988.*

[267] See, for example, the four accidents described at *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=573832&id=14373955&id=200350395&id=569988.*

- adjusting an employee's hardhat,
- maneuvering a tool onto an energized part with a reasonable amount of over- or under-reaching,
- reaching for, and handling, tools, material, and equipment passed to him or her, and
- adjusting tools and replacing components on them, when necessary during the work procedure.

Figure 1 in final Appendix B depicts an example of the range of reasonably likely movements by an employee.

OSHA believes that it is important for employers to train employees not only in the applicable minimum approach distances, but also in how to maintain those distances. Proposed Appendix B explained this approach, stating: "The training of qualified employees required under § 1926.950 and the job planning and briefing required under § 1926.952 must address selection of the proper working position." To clarify this point, final § 1926.950(b)(2)(iii) requires employers to train qualified employees in 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*" (emphasis added to show the new language). (See the discussion of this provision earlier in this section of the preamble.) Final § 1926.952(b) requires the job briefing to cover personal protective equipment requirements and the procedures employees are to use in performing the work. OSHA interprets this provision as requiring the job briefing to address the selection of the proper working position under final § 1926.960(c)(1)(iii) and (d)(2).

EEI counsel Mr. Stephen Yohay and Mr. Clayton Abernathy with OG&E Energy Corporation indicated that information in Appendix B to proposed Subpart V, and the requirements in proposed paragraphs (c)(2)(ii)(a) and (d), led EEI to believe that OSHA was increasing the ergonomic component of the minimum approach distance by 0.61 meters, for a total ergonomic component of 1.22 meters (Tr. 1079–1082). EEI commented:

> In the proposed preamble, OSHA states it is necessary to add the reach component since many injuries resulted from violation of MAD. EEI requests that OSHA place in the record the evidence on which it relies to substantiate this change. EEI also suggests that if, in fact, OSHA's reasoning is correct and employees did cross the imaginary 24 inch line in the past, why and how does OSHA believe that employees will not cross a 50 inch line in the future? [Ex. 0227]

Testifying on behalf of EEI, Mr. Abernathy described how increasing the minimum approach distance by 0.61 meters would restrict some of the work his company's employees do (Tr. 1055–1078). He described two scenarios that he claimed would be affected by this increase—an apprentice line worker working on the secondary conductors on a distribution transformer and a line worker installing insulating protective equipment on overhead conductors. The apprentice in Mr. Abernathy's first example was wearing rubber insulating gloves rated for the secondary voltage, but not for the 15-kilovolt primary voltage (Tr. 1058–1059).

As explained previously in this preamble, the ergonomic component for voltages addressed by EEI's comments is 0.61 meters; it is not 1.22 meters as Messrs. Abernathy and Yohay claimed. The Agency believes that EEI's confusion stemmed from a common misperception of how minimum approach distances work in practice. Some employers mistakenly believe that the ergonomic component of the minimum approach distance accounts for all movement on the part of the employee. As described previously, this is not the case. The minimum approach distance sets a boundary that the employee may not penetrate as he or she is working. To ensure that employees do not penetrate this boundary as they are working, the employer must instruct workers how to position themselves so that reasonably likely movements do not bring the employees inside that boundary. Paragraph (d)(2) of the final rule ensures that employees who are not protected against exposure to energized parts are working at a safe distance from the parts. The final standard generally provides that an employee performing work near exposed parts energized between 601 volts and 72.5 kilovolts must work from a position where he or she cannot reach into the minimum approach distance. This positioning requirement does not apply if the employee is 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.[268]

As noted previously, OSHA concluded that there is clear evidence in the record that approaching too close to energized parts kills and injures employees (Exs. 0002, 0003, 0004). In Ex. 0004 alone, there were at least 27 accidents involving employees coming too close to energized parts without using electrical protective equipment.[269] There are at least six accidents in the record involving apprentices coming too close to energized parts without using electrical protective equipment (Exs. 0002, 0003).[270]

As noted by an OSHA witness at the hearing, employers can protect the apprentice in Mr. Abernathy's example by ensuring that the apprentice is working from a position where he or she cannot reach into the minimum approach distance or, if that is not possible, by installing electrical protective equipment on the primary conductors to enable the employee to work within the minimum approach distance of those conductors (Tr. 1087–1088). According to Mr. Abernathy, the primary conductor is 1.0 meter (40 inches) from the secondary conductor on which the apprentice would be working (Tr. 1069, 1071). The minimum approach distance for a 15-kilovolt primary generally is 0.65 meters (26 inches).[271] Thus, the worker could position himself or herself so that he or she could reach 0.34 meters (14 inches) beyond the secondary conductor and still be in compliance with final paragraph (d)(2). In addition, as long as the secondary conductor is below the primary by a distance that is greater than the minimum approach distance, it should be possible under the final rule for the apprentice to work on the secondary without rubber insulating gloves rated for the primary voltage. If the secondary conductor is closer to the

[268] The proposal provided that paragraph (d)(2) did not apply to employees "insulated from the energized parts." The language in the final rule clarifies that the provision does not apply to employees wearing rubber insulating gloves or protected by insulating equipment covering the energized parts. Note that employers must still ensure that employees wearing rubber insulating gloves maintain the minimum approach distance from energized parts on which they are not working unless those parts are insulated from the employee. (See final paragraph (c)(1)(iii).)

[269] There were 27 accidents in which the investigation summary indicated that an employee who was not using electrical protective equipment contacted energized parts. There were many other accidents involving employee contact with energized parts in which the summary did not indicate whether the employee was using electrical protective equipment. The 27 accidents can be found at: *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=512269&id=525675&id=573832&id=755199&id=768101&id=819805&id=894196&id=927830&id=982082&id=14238117&id=14242036&id=14333439&id=14367023&id=14392393&id=14402788* and *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=14403315&id=14482723&id=1700748018id=170118475&id=170189849&id=170672547&id=170891014&id=171054430&id=200010163&id=200010338&id=201520301&id=201750080.*

[270] See the six accidents described at *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=200010163&id=201440013&id=14345318&id=170170179&id=789354&id=711960.*

[271] The minimum approach distance for 15 kilovolts is 0.65 meters at elevations of 900 meters or less, but increases at higher elevations.

primary conductor than the minimum approach distance, the existing standards (§§ 1926.950(c)(1) and 1910.269(l)(2)) already prohibit employees from working on the secondary conductor without using electrical protective equipment rated for the primary voltage on either the primary conductor or the employee.

Final paragraph (d)(2) does not apply to voltages of 600 volts and less. Much of the work performed at these lower voltages involves the use of insulating hand tools in a panelboard or cabinet. The chance of contacting a live part during this work is low because of the layout of live parts within the enclosure and the use of the insulated tool to maintain a safe distance from the live parts. The electrical clearances between energized parts for voltages in this range are small enough that all energized circuit parts normally will be in front of the employee, enabling the employee to maintain the required minimum approach distance easily. This paragraph also does not apply when the voltage exceeds 72.5 kilovolts, because the minimum approach distances generally become greater beyond this voltage and because employees cannot use rubber insulating equipment for protection at these higher voltages.

Mr. Lee Marchessault of Workplace Safety Solutions recommended that paragraph (d)(2) apply to exposed parts energized at more than 300 volts rather than 600 volts, noting that this application would expand the scope of the requirement to "underground, power plant and meter work on exposed 480 volt secondary systems" (Ex. 0196).

As explained previously, and in the preamble to the proposed rule (70 FR 34865), employees typically use insulated tools to work on this equipment. In addition, a working position requirement is inappropriate for this equipment because much of this equipment is at ground level, where employees easily and frequently adjust their working positions while they work. (In contrast, when employees are working at elevated locations, where employees perform most of the energized work on higher voltages, employees work from a fixed position determined by the location of an aerial lift platform or their positioning straps. Therefore, the Agency did not adopt Mr. Marchessault's recommendation to expand the scope of final paragraph (d)(2).

Proposed paragraph (d)(2) did not apply to situations involving employees insulated from the energized parts or performing live-line barehand work. However, many rulemaking participants expressed concern that proposed paragraph (d)(2) did not fully account for work practices involving the use of live-line tools. (See, for example, Exs. 0125, 0127, 0149, 0151, 0155, 0159, 0164, 0172, 0179, 0188, 0226, 0471; Tr. 1237, 1245–1246.) The comments of Ms. Tracy Harness with the Northwest Line Constructors Chapter of NECA typified these concerns:

> This requirement proposes to add a greater working distance for an employee working near energized exposed parts at more than 600 volts, but not more than 72.5 kilovolts if the employee is not insulated from the energized exposed part or performing live-line bare-hand work. This additional distance is proposed to prevent an employee from accidentally reaching into the minimum approach distance from their working position without protection . . . In many states employees use insulated sticks to perform work on energized parts above 600 volts. On page 34862 of the **Federal Register** it appears that OSHA recognizes the difference when using an insulated stick by not requiring this additional distance for work above 72.5 kilovolts. A number of states do not allow the use of protective gloves to work on energized parts above 5,000 volts. There are no requirements for employees to wear insulated gloves when using an insulated stick.
>
> Will OSHA consider an employee using an insulated stick exempt from having to maintain the added positioning distance for all voltages above 600 volts?
>
> If not, we request that OSHA reconsider this issue due to the increased ergonomic risk it will place on employees. Requiring employees to hold the stick at a greater distance from the object they are handling or working on can put more stress on wrists, elbows and shoulders by changing the leverage point. We do not believe that the industry fatalities that support the proposed change occurred while employees were using insulated sticks. [Ex. 0188]

A live-line tool used by an employee to work on an energized part insulates the employee from that part. As noted earlier and in the preamble to the proposed rule (70 FR 34862), a live-line tool holds the energized part at a distance. Using a live-line tool, an employee can easily maintain minimum approach distances, at least once the tool is engaged with the energized part. The working position requirement in proposed paragraph (d)(2) did not apply to employees insulated from the energized parts, including employees working on live parts with live-line tools. However, there may be energized parts in the work area other than the one the worker is handling with the tool, and he or she would not be insulated from those parts by the live-line tool. Thus, it was less clear from the language in the proposed rule whether a worker using a live-line tool on one part would be required to position himself or herself out of reach of the minimum approach distances from other energized parts.

OSHA examined the accident reports in Ex. 0004 and found that only five of the 800 accidents in that database involved employees using the live-line tool work method approaching too close to an energized part operating between 600 volts and 72.5 kilovolts (Ex. 0004).[272] This compares to the 27 other accidents involving uninsulated employees coming too close to energized parts noted previously. In addition, employees using live-line tools generally are looking in the direction of the live parts, are constantly aware of the presence of energized parts, and position themselves by means of the live-line tool at a fixed distance from the energized part on which they are working. Thus, it is much less likely that these employees (compared to employees not working on energized parts) will inadvertently encroach on the minimum approach distances for parts not being worked on. The Agency concludes that, although there is still some risk for employees using live-line tools, that risk is much lower than for employees not insulated at all from energized parts. Consequently, OSHA is adopting the commenters' suggestion and is exempting work performed with live-line tools from final paragraph (d)(2). This exemption only applies to work performed using live-line tools. Thus, an employee who is hanging hardware on a pole without the use of a tool or electrical protective equipment must be in a position where he or she cannot reach into the minimum approach distance of any part energized at 601 volts to 72.5 kilovolts, even if the employee performs other work on that pole using live-line tools. OSHA revised the language in Appendix B addressing the issue of proper work positioning to explain clearly how to comply with the minimum approach-distance requirements adopted in the final rule.

Paragraph (e) of § 1926.960 in the final rule, which is being adopted without substantive change from the proposal, addresses the practices of connecting and disconnecting lines and equipment. Common industry practice, as specified in the 2002 NESC, Rule 443F,[273] is for employees to make connections by connecting the source as the last item in the sequence and to break connections by removing the source as the first item in the sequence (Ex. 0077). These practices, specified by

[272] See the five accidents described at *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=170378616&id=170577688&id=170336325&id=170089197&id=792739.*

[273] The 2012 NESC contains the same requirement in Rule 443F.

paragraphs (e)(1) and (e)(2) in the final rule, will ensure that the wire or device handled by an employee remains deenergized as long as possible, thereby minimizing the chance that an electrical accident will occur. Also, to prevent energizing any disconnected conductors, employers must ensure that employees keep loose ends of conductors away from exposed, energized parts, as required by final paragraph (e)(3). These three provisions, which have no counterparts in existing Subpart V, duplicate the requirements of existing § 1910.269(l)(5).

Paragraph (f) of final § 1926.960, which OSHA adopted from existing § 1910.269(l)(6)(i), provides that, when employees perform work within reach of exposed, energized parts, the employer must ensure that each employee removes, or renders nonconductive, all exposed conductive articles, such as keys or watches, if those articles would increase the hazards associated with contact with the energized parts. If an employee wears metal jewelry, he or she could cover the jewelry so as to eliminate the contact hazard. This requirement does not preclude workers from wearing metal rings or watch bands if the work already exposes them to electric-shock hazards and if the metal would not increase those hazards. (For example, for work performed on an overhead line, the wearing of a ring would not increase the likelihood that an employee would contact the line, nor would it increase the severity of the injury should contact occur.) This requirement protects employees working on energized circuits with small clearances and high current capacities (such as some battery-supplied circuits) from severe burn hazards. The rule also protects workers minimally exposed to shock hazards from injuries resulting from a dangling chain's making contact with an energized part. This provision has no counterpart in existing subpart V.

The North Carolina Department of Labor recommended expanding the list of prohibited articles or discussing other conductive articles in the preamble to the final rule (Ex. 0098). The State agency pointed to an OSHA interpretation related to a comparable provision in existing § 1910.333(c)(8).

The interpretation to which the North Carolina Department of Labor referred was an intraagency memorandum dated December 30, 1993, and it related to whether § 1910.333(c)(8), which is similar to proposed § 1926.960(f), prohibits metal eyeglasses.[274] This interpretation reads as follows:

> Eyeglasses with exposed metal parts are considered "Conductive apparel". As noted in the middle of column 2 of page 32007 of the preamble published in Volume 55, Number 151 of the **Federal Register** on Monday, August 6, 1990, the Electrical Safety Related Work Practice standard at 1910.333(c)(8) prohibits employees from wearing conductive objects in a manner presenting an electrical contact hazard. Normally, the wearing of eyeglasses containing exposed metal frames (or metal parts of frames) is not considered to present an electrical contact hazard. However, when the glasses have a metal type frame and the employee is working with his or her face extremely close to energized parts or when a metallic chain strap is attached to the frame for wearing around the neck, an electrical contact hazard can be present. In such cases, the standard permits the hazard to be removed by eliminating the chain and wearing either a protective face shield or appropriate safety glasses over the metal frame optical glasses.

OSHA confirms that this interpretation also applies to paragraph (f) of the final rule. However, because eyeglasses would rarely pose the hazards addressed by this provision, the Agency concludes that it is not necessary to mention eyeglasses as an example of the type of conductive article prohibited by paragraph (f). Therefore, OSHA is adopting paragraph (f) in the final rule without substantive change from the proposal.

Protection From Flames and Electric Arcs

Paragraph (g) of the final rule addresses protective clothing and other personal protective equipment worn by employees exposed to hazards posed by flames and electric arcs. OSHA revised the title of paragraph (g) in the final rule to "Protection from flames and electric arcs" to reflect more accurately that this paragraph addresses forms of protection other than protective clothing. (For the same reason, OSHA included language in final paragraph (g)(5) to be clear that that provision requires both protective clothing and other protective equipment.) In the 1994 rulemaking on § 1910.269, OSHA determined that electric power generation, transmission, and distribution workers face a significant risk of injury from burns due to electric arcs (59 FR 4388). In that rulemaking, OSHA also concluded that certain fabrics increase the extent of injuries to employees caught in an electric arc or otherwise exposed to flames (59 FR 4389). Therefore, the Agency adopted two rules: (1) Existing § 1910.269(l)(6)(ii), which requires that employers train employees exposed to flames and electric arcs in the hazards related to the clothing that they wear, and (2) existing § 1910.269(l)(6)(iii), which requires employers to ensure that employees exposed to flames or electric arcs do not wear clothing that, when exposed to flames or arcs, could increase the extent of injuries sustained by the workers. A note following existing § 1910.269(l)(6)(iii) indicates the types of clothing fabrics that the § 1910.269 rulemaking record demonstrated were hazardous when worn by employees exposed to electric arcs, namely, acetate, nylon, polyester, and rayon. The note explains that the standard prohibits the use of clothing made from these types of fabric unless the employer can demonstrate that the fabric was treated to withstand any relevant conditions or the employee wears it in a manner that eliminates the hazard.

Need for protection from electric arcs and hazard assessment. Even after existing § 1910.269(l)(6) became effective,[275] employees continue to sustain burn injuries when working on energized lines and equipment. In the preamble to the 2005 Subpart V proposal, OSHA noted that, from January 1, 1990, to October 30, 1994, there were 46 accidents investigated by Federal OSHA or State-plan occupational safety and health agencies involving burns addressed later by § 1910.269(l)(6)(iii) (70 FR 34866). These 46 accidents resulted in 71 total injuries (*id.*). Averaged over this period, there were 9.5 accidents and 14.7 injuries per year. Also in the preamble to the 2005 proposal, OSHA noted that, from November 1, 1994 (when § 1910.269(l)(6)(iii) became effective), to December 31, 1998, there were 17 relevant accidents resulting in 26 injuries (*id.*). Averaged over this period, there were 4.0 accidents and 6.2 injuries per year. Thus, while the clothing rule in § 1910.269 appeared to reduce the number of relevant accidents and injuries by more than 50 percent, OSHA believed that the remaining risk of burn injury was still serious and significant when it published the proposal in 2005.

OSHA based its belief that the risk of burn injury was serious and significant on two assumptions. First, the accidents identified in the 2005 preamble

[274] This memorandum is available at *http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=21350.*

[275] The original **Federal Register** notice promulgating § 1910.269 set an effective date for § 1910.269(l)(6) of May 31, 1994 (59 FR 4320). However, OSHA subsequently stayed the enforcement of § 1910.269(l)(6)(iii) until November 1, 1994 (59 FR 33658; June 30, 1994).

represented only a small fraction of the accidents that occurred during this period because employers must report to the Agency only accidents involving a fatality or three or more hospitalized injuries (29 CFR 1904.39(a)). In this regard, OSHA generally does not investigate accidents that are not reported by employers (see OSHA directives CPL 02–00–150 and CPL 02–00–094). Therefore, OSHA does not investigate, or have documentation of, most injury-producing accidents, even serious ones, so data on these accidents are not included in the information that OSHA reviewed. Second, the reported burn injuries identified in the 2005 preamble were extremely serious and costly. Eighty-four percent of the burn injuries were fatalities or required hospitalization (70 FR 34866). Eighty-seven percent of the accidents for which the report lists the severity of the injury involved third-degree burns (*id.*). Such burns are extremely painful and costly, typically requiring skin grafts and leaving permanent scars.

Dr. Mary Capelli-Schellpfeffer testified as OSHA's expert witness on the subject of protecting workers from the hazards posed by electric arcs. Dr. Capelli-Schellpfeffer received her medical degree from the University of Florida in 1982. She also holds a master's degree in public administration. Following her postgraduate medical training and several years in private practice, Dr. Capelli-Schellpfeffer served as the medical director of Wisconsin Energy Company, which included an electric utility and a nuclear power generating plant. She joined the University of Chicago, Department of Surgery Faculty, in 1993, where she served as the director of the hyperbaric unit of the University of Chicago Burn Center. Since 1999, she has worked as a consultant, researcher, and teacher, and has treated employees in outpatient clinical settings. She is licensed as a physician in Wisconsin, Illinois, and Maryland, and she is board certified by the American College of Preventive Medicine. Dr. Capelli-Schellpfeffer is also a member of the American College of Occupational and Environmental Medicine and a fellow of IEEE (Tr. 175–177).

In her prepared testimony for the 2006 public hearing, Dr. Capelli-Schellpfeffer described the physical properties of an electric arc and possible injury following exposure to an arc as follows:

> [A]n electric arc exposure in a 480 V installation with 22.6 kA available current is . . . captured on video from a high voltage test laboratory. . . . In the . . . test, data results showed peak monitored temperature exceeded 225 degrees C in 10 ms at the mannequin's hand, and at the mannequin's neck at 120 ms. Cooling of the hand to 70 degrees C required more than 2500 ms.
>
> The injuries that accompany high temperature exposures at the body surface are commonly referred to as skin burns. High temperature exposures that occur volumetrically, or that distribute *within* the body's tissues, are also called burns. The term *burn* generally refers to a physico-chemical change in the human tissue.
>
> For example, most people are familiar with the appearance of a superficial sunburn, and how painful this can be. As the skin's appearance changes more severely, the burn trauma is more profound, and can affect other organ systems. When skin changes are irreversible and irreparable, the trauma is severe.
>
> Other organs beside the skin can be burned. The mechanism or way organ injury unfolds in response to temperature is again sensitive to the temperature peak, duration, and biophysical processes.
>
> Additionally, the form of energy which creates the temperature rise can influence the injury, once more because of biophysical processes. For example, temperature change in the eye and recognition of the resulting injury from conductive heat exposure (like a piece of molten metal on the cornea) will be different than the injury from a radiation exposure (like UV light).
>
> The latent heat of melting subsequent to an electric arc can also serve as an ignition hazard for clothing. This means that along with the hazard from an arc's heat burning the skin, there is additional possibility of severe harm from the arc burning up clothing which lies against the skin. Burning clothing against the skin creates damage to the skin through conductive heating for the extended time which might be necessary to extinguish the clothing and start cooling.
>
> * * * * *
>
> [T]est results illustrated the high degree of variability in electric arc faults and led to excerpts of video images into time-lapsed photographs. The test results also provided exposure data. Finally, the stop action frames of video recordings permitted visualization of the dynamic changes in the tests involving the mannequin worker.
>
> Of particular note in the stop action frames of video recordings is the explosive speed and "blast" character of electric arcs. These images allow for the viewing of a destructive plasma ball, flames, and waves of air, smoke, and other gases.
>
> The heating from the sub-second thermal expansion of air and vaporization by sublimation of metallic conductors leads to pressure waves, referred to as the "thermo acoustic effect" of an electric arc.
>
> * * * * *
>
> [A picture] illustrates the extent of injury that can follow an electric arc exposure. Eyes, ears, face, skin, limbs, and organs are affected. Basic bodily function, including the ability to breath[e], eat, urinate, and sleep are completely changed. For this patient, initial medical treatment cost more than $650,000, including five surgeries; $250,000 for reconstructive surgeries for five subsequent admissions; and $250,000 for [5] years of rehabilitation including over 100 physician visits and numerous therapy sessions. These costs represent only direct medical expenditures, without inclusion of indirect employer and family costs . . . . [Ex. 0373; emphasis included in original]

Dr. Capelli-Schellpfeffer's testimony reveals the power and injury-producing effects of electric arcs. She also highlights the potential extent and costs of these injuries.

OSHA's existing clothing requirement in § 1910.269 does not require employers to protect employees from electric arcs through the use of flame-resistant (FR) clothing. It simply requires that an employee's clothing do no greater harm. Because the remaining risk to power workers from electric arcs is serious, the Agency proposed to revise the standard to require the use of flame-resistant clothing, under certain circumstances, to protect employees from severe burns. As OSHA noted in the preamble to the proposal (70 FR 34866), the electric power industry is beginning to recognize this need, as evidenced by the many employers that provide flame-resistant clothing to employees (see, for example, Ex. 0080), in ASTM standards that provide for arc ratings of protective clothing[276] (see, for example, Exs. 0061, 0065, 0131, 0326), and by the adoption of protective-clothing requirements in the 2007 NESC[277] (Ex. 0533). The National Fire Protection Association also recognizes the need to protect employees working on energized equipment from the hazards posed by electric arcs (see, for example, Ex. 0134).

When OSHA promulgated § 1910.269, there were no standards for clothing to protect employees from the thermal hazards resulting from electric arcs. Since then, ASTM adopted such standards (see, for example, Exs. 0061, 0065, 0131, 0326). These standards ensure that clothing does not ignite and that it is rated to provide protection against a specific level of heat energy. Manufacturers label apparel meeting the ASTM standards with the amount of heat energy that the clothing can absorb under laboratory test conditions without letting through sufficient heat to cause a second-degree burn.[278] Such clothing

[276] ASTM also has standards for other arc-protective equipment, including ASTM F2178–08, *Standard Test Method for Determining the Arc Rating and Standard Specification for Face Protective Products.*

[277] The 2012 NESC also contains protective-clothing requirements.

[278] OSHA explains the arc rating for clothing in the summary and explanation for final paragraph (g)(5), under the heading *Selecting arc-rated protective clothing and other protective equipment,* later in this section of the preamble.

currently is widely available in ratings from about 4 cal/cm^2 to over 50 cal/cm^2 (Tr. 412). In general, the higher the rating, the heavier the clothing; however, lighter fabrics now provide a level of protection equivalent to heavier fabrics used in the past (Tr. 440).

Some rulemaking participants generally supported OSHA's proposal to require the use of FR clothing[279] in certain circumstances. (See, for example, Exs. 0155, 0230, 0235, 0241, 0505; Tr. 895–897.) IBEW, ESCI, and the Independent Electrical Contractors, among others, supported FR clothing requirements (Exs. 0155, 0230, 0241, 0505; Tr. 895–897). ORC voiced general support for the proposal's approach to arc-flash protection, commenting:

> ORC generally supports the proposed requirements to protect employees from the thermal hazards of electric arcs. Assessing the potential for employee exposure to hazards from flames or electric arcs is appropriate for employees working with or near energized equipment and where their work clothing could be ignited directly by molten metals or electric arcs or by flammable materials ignited by an electric arc. Prohibiting the wearing of clothing that could melt or ignite and requiring the wearing of flame-resistant and appropriate arc-rated clothing based on the extent of the hazards present are also appropriate. [Ex. 0235]

Many electric utility representatives generally opposed the proposed requirements for protection from electric arcs. (See, for example, Exs. 0177, 0183, 0202, 0220, 0227, 0233, 0238, 0401; Tr. 371–374, 1093–1104, 1184–1185.) Some of these rulemaking participants suggested that the requirements in existing § 1910.269 were sufficiently protective and that there was insufficient evidence of a need to adopt more protective requirements. (See, for example, Exs. 0177, 0181, 0227.) For instance, Consumers Energy stated that, in its experience, existing § 1910.269(1)(6)(iii) "has been largely effective" (Ex. 0177). Some commenters argued that the accidents that occurred were the result of employees violating safety-related work rules. (See, for example, Exs. 0152, 0238.) For instance, Mr. Frank Owen Brockman with Farmers Rural Electric Cooperative Corporation commented: "Most people are . . . injured not by arcs and their heat, but by not following the simple, most basic rules" (Ex. 0401).

OSHA acknowledges that the adoption of existing § 1910.269 in 1994 led to a reduction in the number (and potentially the severity) of burn and other injuries incurred by power line workers exposed to electric arcs. However, the Agency concludes that existing § 1910.269 has not been sufficiently protective in preventing these injuries.

As noted earlier, the 6.2 injuries per year that OSHA identified as being caused by electric arcs represent only a small fraction of such injuries experienced by electric power generation, transmission, and distribution workers. Moreover, the vast majority of the injuries OSHA identified are extremely serious, such as the accident described in Dr. Capelli-Schellpfeffer's testimony.

OSHA's final regulatory analysis estimates that there are 444 serious injuries occurring each year during work addressed by the final rule. This estimate was derived by multiplying the 25 serious injuries actually reported annually over the period examined by a specified correction factor to account for undercounting. (See Section VI, Final Economic Analysis and Regulatory Flexibility Analysis, later in the preamble to the final rule.) Multiplying the 6.2 reported serious arc-related injuries by the ratio of 444 estimated injuries to 25 reported injuries yields an estimate of 110 serious arc-related injuries still occurring each year. As noted earlier, the vast majority of these injuries involve third-degree burns.

Existing § 1910.269 requires extensive training in electrical safety-related work practices, and evidence in the record indicates that workers covered by this final rule receive extensive training in these practices and are highly qualified to perform electric power generation, transmission, and distribution work. Mr. Albert Smoak with Southwestern Electric Power Company stated, "We have a very extensive apprentice program. And so we spend lots of money doing that. Our apprentices are very well trained" (Tr. 1229). Mr. William Mattiford of Henkels & McCoy testified, "Employees are trained either by Henkels and McCoy or other construction companies or have undergone extensive training in a certified apprenticeship program" (Tr. 1318–1319). Similar statements appear elsewhere in the rulemaking record. (See, for example, Tr. 1238–1239.) As the data show, however, serious arc-related incidents continue to occur during work covered by this final rule. Even Mr. Brockman recognized that "in the majority of [accidents], the fatality involved [a] worker who had been appropriately trained for the exposure" (Tr. 1278).

It would be contrary to the purposes of the OSH Act for the Agency to set standards based on an expectation that there will be perfect compliance with work-rule requirements. To be effective, such work-rule provisions rely, in part, on employee compliance with employer work practices. Because there will always be occasional instances of noncompliance with work rules, OSHA standards incorporate secondary protective measures. Moreover, arcs can occur as a result of circumstances that work rules cannot control. For example, electric arcs can result from accidents, such as an employee's dropping a tool onto energized parts (Ex. 0004[280]). According to Dr. Capelli-Schellpfeffer, other causes of electric arcs on electric utility systems include transient overvoltage disturbances (such as lightning, switching surges, arcing ground fault in ungrounded systems), mechanical breaking, cracking, loosening, abrading or deforming of static or structural parts, and shorting by animals (Ex. 0373). These types of electric arcs generally do not result from poor work practices. Exhibit 0004 describes 100 accidents involving electric arcs. More than 10 percent of those accidents involved equipment failure or internal faults.[281] Dr. Capelli-Schellpfeffer testified about one of the reasons for this type of event:

> There is more available power in the electric system, and the higher availables put more stress, electromechanical stress, on the infrastructure, at the same time that the infrastructure that we have installed is mature. It is aging. And so there is a transition in the experience of the power systems from fairly low levels of available power and a relatively young infrastructure from the time of the 1950s and '60s, to where we are today at the beginning of the 21st century where the availables are orders of magnitude higher, and the infrastructure is far more mature. [Tr. 205–206]

IBEW explained:

> Arcs can occur for reasons totally independent of the conduct of employees or the utilities or contractors. Thus, arcs can result from the presence of rodents, changes in mechanical properties, environmental

[279] The final rule requires arc-rated clothing (which also is flame-resistant) in some circumstances and FR clothing in others. When the distinction is unimportant, as when discussing general comments on the need for protective clothing, OSHA uses the term "FR clothing," even though the final rule may require that clothing also be arc rated. For a detailed explanation of the difference between FR clothing and arc-rated clothing, see the summary and explanation for final paragraph (g)(5), under the heading *Selecting arc-rated protective clothing and other protective equipment*, later in this section of the preamble.

[280] See, for example, the accident described at *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=201841061.*

[281] See the 12 accidents described at *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=201340395&id=170749873&id=170632699&id=170762769&id=143435948&id=170238109&id=170891899&id=170358428&id=170888259&id=170727697&id=142418638&id=170193353.*

conditions or the amount of stress that increasing amounts of available power are putting on the aging infrastructure. [Tr.] 205, 207. Arc events are complicated and variable, and no one strategy for preventing or protecting against them will be "maximally protective." Moreover, whatever the reason for an arc flash, the fact is that they occur in the electrical transmission and distribution industry, and there are measures that can be taken to minimize the hazard they pose to employees. As Dr. Capelli-Schellpfeffer noted, employee protection requires a "multifactorial approach," [Tr.] 210, which includes the use of FR clothing so that if all else fails, employees will remain protected. [Ex. 0505]

The Agency, thus, continues to believe that further reductions in the number and severity of arc-flash-related injuries will result from adopting requirements that provide protection from electric arcs in a way that supplements the existing requirements in § 1910.269 designed to prevent electric arcs and the ignition of clothing when arcs do occur. OSHA concludes that, under existing § 1910.269 and subpart V, the risks associated with electric arcs warrant additional protection for employees.

The Agency does agree with APPA, however, that protective clothing "is not a comprehensive solution to eliminating fire related injuries in [the electric utility] industry" (Ex. 0504). Paragraph (g) of the final rule protects employees in case an electric arc occurs in spite of other provisions in the final rule designed to prevent them from happening in the first place.

The National Association of Manufacturers (NAM) recommended that, even if the Agency found that there is a significant risk of arc-flash burns for activities covered by this final rule, it should state clearly that no findings indicate whether there is significant risk for activities outside the scope of the final rule (Ex. 0222). The association maintained that §§ 1910.132 and 1926.95 do not presently require arc-flash hazard assessments or arc-rated clothing and that there is no justification for citations under those standards or the general duty clause. NAM also recommended that the Agency instruct its enforcement personnel not to issue such citations.

The risk findings OSHA makes in this preamble regarding hazards posed by electric arcs address only the types of work covered by this final rule. However, some existing general industry and construction standards already address these hazards. For example, § 1910.335(a)(2)(ii) requires the use of protective shields, barriers, or insulating materials "to protect each employee from shock, burns, or other electrically related injuries while that employee is working . . . *where dangerous electric heating or arcing might occur*" (emphasis added). Furthermore, § 1926.95(a) requires personal protective equipment "wherever it is necessary by reason of hazards of processes or environment, chemical hazards, radiological hazards, or mechanical irritants encountered in a manner capable of causing injury or impairment in the function of any part of the body through absorption, inhalation, or physical contact." Also, the generally applicable PPE provisions for both general industry and construction—§§ 1910.132(a) and 1926.95(a)—specifically mention "protective clothing" as one form of required protection. The Agency described its enforcement policy relating to the protection of employees from electric-arc hazards in certain situations not covered by this final rule in several letters of interpretation. (See, for example, the November 14, 2006, letter to Ms. Joanne Linhard and the February 29, 2008, letter to Mr. Brian Dolin.[282])

Several commenters argued against the proposed requirements for arc-protective clothing on the grounds that it is expensive and uncomfortable. (See, for example, Exs. 0158, 0183, 0202, 0229, 0233, 0239.) For instance, NRECA commented:

> Data so far suggest that arc protective clothing is expensive and is uncomfortable to wear, especially in hot and humid climates. Of course, the discomfort in wearing arc protective clothing is largely because it must act as a heat shield and, therefore, it is inherently bulky. [Ex. 0233]

OSHA finds that the costs associated with the requirements of paragraph (g) of the final rule are commensurate with the benefits resulting from those requirements. (For a detailed response to this issue, see the discussion of comments on balance of risk and costs in employing protective equipment to prevent arc-related burns in Section VI, Final Economic Analysis and Regulatory Flexibility Analysis, later in the preamble to the final rule.)

As explained later in this section of the preamble, OSHA determined that the PPE required by paragraph (g) of the final rule is not likely to be unduly uncomfortable for employees to wear. In any event, the Agency does not believe that discomfort alone would justify deleting § 1926.960(g) from the final rule. Complaints that PPE is uncomfortable have been common throughout the Agency's history. For example, employees have complained that hard hats and eye protection are too uncomfortable to wear. (See, for example, *I.T.O. Corp. of New England v. OSHRC,* 540 F.2d 543, 546 (1st Cir. 1976), noting "employee complaints that the [hard] hats created minor inconveniences e.g., because they were too heavy, too light, too hot, or too cold"; and *Lewis County Dairy Corp.,* 2006 WL 3247249, at *10 (03–1533, 2006) (ALJ), noting that "[the plant manager] knew that employees did not always wear eye protection and that it was difficult to get them to do so as they found it uncomfortable.") In this rulemaking, the tree trimming industry complained that employees find body harnesses uncomfortable. (See, for example, Exs. 0174, 0200, 0219.) Although OSHA generally advises employers to take the comfort of protective equipment into consideration when selecting appropriate protective items for their employees, the Agency concludes that the potential for complaints about comfort does not outweigh the strong evidence that there is a safety need for employees covered by this final rule to use PPE when exposed to electric-arc hazards.

Paragraph (g)(1) of the final rule, which is being adopted without substantive change from the proposal, requires the employer to assess the workplace to identify employees exposed to hazards from flames or electric arcs.[283] 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. Because final § 1926.960 applies to work performed on or near exposed, energized parts of electric circuits, employers do not need to conduct assessments under paragraph (g)(1) for employees who do not perform such work. However, until the employer ensures the complete deenergization of a line or part of an electric circuit following the procedures required by final § 1926.961, including any required testing and grounding, the line or part must be considered and treated as energized as required by final § 1926.960(b)(2). Also, final paragraphs (g)(2) through (g)(5) protect employees only from the thermal hazards posed by flames and electric arcs. Therefore, if

[282] The Dolin letter is available at *http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=25973.*

[283] Under paragraph (g)(1), employers need not identify employees by name. The required identification can also be occupation based, task based, or location based provided that each employee exposed to hazards from flames or from electric arcs receives the protection that paragraph (g) requires.

the hazard assessment required by paragraph (g)(1) shows employee exposure to other hazards, then other standards, such as §§ 1910.132(a) and 1926.95(a), may require the employer to provide PPE for those hazards. (See the discussion under the heading *Protecting employees from flying debris from electric arcs,* later in this section of the preamble.)

Final paragraph (g)(1) requires the employer to assess the workplace to identify employees "exposed to hazards from flames or from electric arcs." A few commenters requested that OSHA define this phrase in the final rule (Exs. 0170, 0222, 0237). These commenters argued that simply operating electric equipment, such as a disconnect switch in an electrical box, does not pose a significant risk of injury from an electric arc. For example, the American Forest & Paper Association stated these concerns as follows:

> [W]e are concerned that the language of proposed Sections 1910.269(l)(11) and 1926.960(g) could have unintended consequences if interpreted to apply to employees not exposed to a significant risk * * *
>
> * * * * * *
>
> [W]e do not believe the individual who opens or closes the electrical disconnect on an enclosed electrical box or panel with the cover on/closed would be exposed to a significant risk of harm from arc flash hazards, but that is not clear from the proposed regulatory text or the preamble. A contrary interpretation would involve a huge increase in the cost of both the proposed standards and their potential extension outside the Electric Power Sector. [Ex. 0237; emphasis in original; footnote omitted.]

If the employer properly installs and maintains enclosed equipment and if there is no evidence of impending failure, the risk that an electric arc will occur is low enough that the Agency would not deem there to be exposure to electric-arc hazards.[284] For the purposes of final paragraph (g), OSHA will consider an employee "exposed" to electric-arc hazards whenever there is a reasonable likelihood that an electric arc will occur in the employee's work area. The Agency considers there to be a reasonable likelihood that an electric arc will occur whenever the probability of such an event is higher than it is for the normal operation of enclosed equipment.[285]

In contrast, whenever the risk that an arc will occur is higher than the risk of such an occurrence posed by the normal operation of enclosed equipment, the Agency considers electric-arc hazards to be present. For example, operating equipment that is not enclosed (for example, racking in a circuit breaker) poses such a risk (Ex. 0004[286]). Conductive objects can fall onto exposed live parts and cause an arc. Evidence that the equipment may be defective, for example, arcing noises or unusual behavior or heating, indicates that there is employee exposure to the hazards of electric arcs (*id.*[287]). Also, working near energized parts exposes employees to electric-arc hazards whenever the employee or another conductive object can contact those energized parts and other parts at a different potential (*id.*[288]). (See the definition of "exposed" and the summary and explanation for final § 1926.960(b)(3), earlier in this section of the preamble.)

With respect to the American Forest & Paper Association's comment about opening and closing disconnects in an enclosed electrical box, evidence in the record indicates that equipment enclosures do not always provide adequate protection against electrical faults (Ex. 0373). A paper by Jones *et al.*[289] described the results of one arcing-fault test as follows: "the fault blew the door open and progressed up the vertical bus, completely destroying the vertical section of the [motor control center]" (*id.*). A paper by Land[290] described problems the Navy had in 1979 with arcing faults in switchboards: "These arcs could completely destroy a switchboard within a matter of seconds" (*id.*). Although these events may be uncommon, OSHA believes that it is appropriate for the standard to require the employer to assess the hazards posed by different operations and distinguish conditions that expose employees to electric-arc hazards from conditions that do not. For example, employers may consider a properly maintained switch as posing no electric-arc hazards when an employee is opening it under normal conditions. On the other hand, if there is evidence that the switch may be faulty or if the employee is opening the switch to troubleshoot the circuit, OSHA would expect the employer to assume that the switch does pose electric-arc hazards. Evidence that a switch may be faulty can include the presence of arcing or unusual noise from the switch, abnormally high temperatures around the switch, and safety bulletins from the switch manufacturer indicating that the device might fail under certain operating conditions. Thus, OSHA concludes that it is not always safe to operate an enclosed switch and, therefore, is not generally exempting such activities from the hazard-assessment requirement in final paragraph (g)(1) or any of the other provisions in final paragraph (g).

OSHA does not believe that applying paragraph (g)(1) of the final rule in this manner will impose substantial extra costs on employers. The Agency anticipates that, in the vast majority of cases, the employer will determine that employees operating enclosed switches will have no exposure to hazards from electric arcs. On the basis of the foregoing discussion, it should be clear that the only occasions that an employee performing a switching operation would have exposure to electric-arc hazards under paragraph (g)(1), and, thus, be required to use arc-rated protection, would be if: a switch or other disconnect may be faulty (which should be rare); an employee operates a switch outside its rating[291] (which also should be rare), or an employee is performing troubleshooting or repair on the switch or a circuit controlled by the switch. In the latter case, the employee will be exposed to those same hazards during the troubleshooting or repair activities, when appropriate arc-flash protection would be required anyway. For the rare cases in which the employer has reason to believe that the switch might fail and expose an employee to an electric-arc hazard, the protection afforded by arc-flash protection would be necessary.

[284] There is still a low risk that the equipment will fail (with or without an employee operating it); however, that risk is low enough that no arc-flash protection is necessary. This risk is equivalent to the risk encountered by employees every day when they turn on the lights.

[285] Basically, OSHA considers there to be a reasonable likelihood that an electric arc will occur when an employee operates enclosed electric equipment in a manner that is not in accordance with the manufacturer's recommendations (that is, normal operation) or when an employee operates enclosed electric equipment that the employer has not maintained properly.

[286] See, for example, the three accidents described at *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=14328736&id=200962322&id=170197156.*

[287] See, for example, the two accidents described at *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=170762769&id=170204622.*

[288] See, for example, the three accidents described at *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=170054258&id=170614002&id=170611057.*

[289] Jones, R. A., Liggett, D. P., Capelli-Schellpfeffer, M., Macalady, T., Saunders, L. F., Downey, R. E., McClung, L. B., Smith, A., Jamil, S., Saporita, V. J., "Staged Tests Increase Awareness of Arc-Flash Hazards in Electrical Equipment," *IEEE Transactions on Industry Applications Society,* 36(2): 659–667, March–April 2000.

[290] Land III, H. B., "The Behavior of Arcing Faults in Low Voltage Switchboards," 2005 IEEE ESTS, Philadelphia, pp. 133–140, 2005.

[291] Operating a switch or other disconnect outside its rating is prohibited by § 1926.960(k) of the final rule.

However, the need to outfit the employee in arc-flash protection in such cases will serve as an incentive to effect repair of the switch and remove the hazard.

Some commenters argued that some utilities perform work with live-line tools, which limits employee exposure to hazards posed by electric arcs and makes FR clothing unnecessary. (See, for example, Exs. 0125, 0171, 0179, 0188, 0226.) NECA also argued that 40-cal/cm^2 arc-flash suits with hoods would reduce manual dexterity to the point that they would interfere with the employee's ability to use live-line tools (Ex. 0171).

OSHA agrees that work with live-line tools exposes employees to a lower incident-energy level than work directly on energized parts with rubber insulating gloves because employees working with live-line tools are normally farther from an electric arc than employees using gloves. (The tables in Appendix E use a method of estimating heat energy that assumes that employees using live-line tools will be substantially further away from the arc than employees using rubber insulating gloves.) All of the incident-energy calculation methods (described later in this section of the preamble) result in energy estimates that are approximately inversely proportional to the square of the distance. This proportion means that, when the employee is twice as far from the electric arc, he or she has exposure to no more than a quarter of the energy. OSHA does not believe that there are many, if any, working conditions that would expose an employee using a live-line tool to an incident energy of 40-cal/cm^2. NECA's example using clothing appropriate for such high exposure contradicts its claim that employees using live-line tools face reduced exposures.

As discussed later in this section of the preamble, final paragraph (g)(4)(iv) requires FR clothing when the estimated incident-energy levels are more than 2.0 cal/cm^2. If live-line tool work practices limit incident-energy levels to that value or less, then paragraph (g)(4) may not require flame-resistant clothing. However, clothing can ignite even at low incident-energy levels. For example, an arc can ignite insulating fluid in transformers and other equipment, which could ultimately ignite clothing (Ex. 0004[292]). Current passing through grounding conductors can melt those conductors and ignite clothing (*id.*[293]). Hot debris from faulted equipment can spew out and ignite clothing (Exs. 0342, 0373). Final paragraph (g)(4), as described more fully later in this section of the preamble, requires flame-resistant clothing in those scenarios. OSHA is not exempting live-line tool work from the hazard assessment or other requirements in paragraph (g) of the final rule. Employers must account for the possibility of clothing ignition from sources other than incident heat energy in the hazard assessment required by paragraph (g)(1) of the final rule.

The American Forest & Paper Association commented that the proposed definition of "exposed" in § 1926.968 does not seem applicable to the use of the word "exposed" in proposed § 1926.960(g) because the definition refers to a conductor or part rather than a person (Ex. 0237).

OSHA agrees that the definition in final § 1926.968 relates only to parts of electric circuits; it does not address employee exposure to hazards other than exposure to live parts.[294] To clarify the application of the definition of "exposed" in § 1926.968 of the final rule, OSHA is adding the parenthetical phrase "(as applied to energized parts)" to the defined term "exposed."

Estimating incident heat energy.[295] Once an employer determines the employees exposed to hazards from flames or electric arcs, the next step in protecting these employees is to determine the extent of the hazard. Paragraph (g)(2) of the final rule, which OSHA revised from the proposal as described later in this section of the preamble, requires the employer to make a reasonable estimate of the incident heat energy to which each employee exposed to electric-arc hazards would be exposed. Under final paragraph (g)(5), employers must use this estimate to select appropriate PPE.

As noted in the preamble to the proposal, OSHA is aware of various methods of calculating values of available heat energy from an electric circuit (70 FR 34866–34867). Table 10, later in this section of the preamble, lists methods that were available when OSHA proposed paragraph (g)(2). 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). Some of these parameters, such as the fault current and the clearing time, are known quantities for a given system. Other parameters, such as the length of the arc and the distance between the arc and the employee, vary depending on what happens to initiate the electric arc and are estimated parameters. It should be noted that NFPA 70E–2004 Annex D contains three different methods of estimating incident heat energy: (1) a method based on a paper by Lee entitled "The Other Electrical Hazard: Electric Arc Blast Burns,"[296] also known as the "Lee equation"; (2) a method based on the Doughty, Neal, and Floyd paper, which Table 10 lists separately; and (3) the IEEE 1584 method, which Table 10 also lists separately.[297] The following discussion refers to the method based on the Lee equation as the NFPA 70E Annex D method.[298]

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[292] See the seven accidents described at *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=200671253&id=201340395&id=170762769&id=170632699&id=14504773&id=14343594&id=837815.*

[293] See the accident described at *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=596304.*

[294] Several provisions in subpart V in addition to final § 1926.960(g) refer to employee exposure.

[295] This preamble uses the term "incident energy" as a synonym for "incident heat energy."

[296] Lee, R. H., "The Other Electrical Hazard: Electric Arc Blast Burns," *IEEE Transactions on Industry Applications,* 1A–18(3):246—251, May/June 1982 (Ex. 0433).

[297] NFPA 70E–2012, Annex D, contains the same three methods plus an additional method for calculating incident heat energy for dc systems. Although OSHA has not evaluated this new method, employers may use it to calculate incident heat energy if it reasonably predicts the incident energy for the system involved.

[298] NFPA 70E–2012, Annex D, also contains the Lee equation. Consequently, OSHA's conclusions regarding the NFPA 70E–2004 Annex D method also apply to NFPA 70E–2012, and Appendix E to final Subpart V references NFPA 70E–2012. Unless otherwise noted, the preamble references to the content of NFPA 70E–2004, Annex D, apply equally to NFPA 70E–2012.

TABLE 10—METHODS OF CALCULATING INCIDENT HEAT ENERGY FROM AN ELECTRIC ARC

1. *Standard for Electrical Safety Requirements for Employee Workplaces,* NFPA 70E–2004, 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.
4. Heat Flux Calculator, a free software program created by Alan Privette (widely available on the Internet).
5. ARCPRO, a commercially available software program developed by Kinectrics, Toronto, ON, CA.

Employee arc exposures. One of the following three separate types of electric arcs typically serves as the basis for the methods used to estimate incident energy: single-phase arc in open air, three-phase arc in open air, and three-phase arc in an enclosure (arc in a box) (Exs. 0425, 0430, 0433, 0463, 0468, 0469). A single-phase arc occurs when electric current arcs from a circuit part for one phase to ground or to a circuit part for another phase. A three-phase arc involves arcing between all three phases of a three-phase circuit. A single-phase arc can escalate into a three-phase arc as the air around the arc ionizes and becomes more conductive (Ex. 0425). Both kinds of arcs can occur in open air or inside an enclosure. The incident-energy levels vary between the types of arcs, with energy levels progressively increasing from single-phase arcs in open air, to three-phase arcs in open air, to three-phase arcs in a box (Exs. 0425, 0430, 0468). OSHA finds that, for an estimate of heat energy to be reasonable, it must account for the type of exposure the employee likely will encounter.

Varying results using different calculation methods. Many rulemaking participants objected to the proposed requirement that employers make a reasonable estimate of the incident heat energy associated with an employee's exposure to an electric-arc hazard. (See, for example, Exs. 0152, 0173, 0178, 0201, 0209, 0227, 0233, 0501; Tr. 374–376, 547–548, 1094–1098, 1100–1102.) Some of these rulemaking participants focused on purported problems with methods of calculating incident heat energy. (See, for example, Exs. 0152, 0173, 0201, 0209, 0227, 0233, 0501; Tr. 547, 1094–1098, 1100–1102.) These commenters maintained that the results of calculations from the different methods varied widely or are subject to manipulation that would make the calculation methods unreliable or unscientific (*id.*). For example, Ms. Kathy Wilmer, testifying on behalf of EEI, spoke to the wide variations she found in calculating incident heat energy using the methods listed in the proposed rule:

> OSHA does not endorse any of the methods listed in the table. OSHA further acknowledges that the method of calculation can affect the results inasmuch as each method yields somewhat different values using the same input parameters.
>
> * * * * *
>
> [F]our methods, including two tables and two formulas, were compared for the conditions of 15,000 volts, 5,000 amps, and 34.5 cycles. The heat energies determined were, No. 1, from Appendix F, Table 8,[299] of the proposal, 5 calories per square centimeter; No. 2, from the HeatFlux Calculator, 2.9 calories per square centimeter; No. 3, from NFPA 70E, Table 130.7(c)(9)(a),[300] 40 calories per square centimeter, as it is listed as risk category 4 [301] for work on energized parts in the other equipment over 1,000-fold category; No. 4, from NFPA 70E, Annex D, D7, formula, 153 calories per square centimeter.
>
> In summary, the results were 2.9, 5, 40, and 153 calories per square centimeter for the same conditions: 15,000 volts, 5,000 amps, 34.5 cycles. Again, this example illustrates serious concerns about the reliability of methods offered to determine heat energy on transmission and distribution systems. [Tr. 1096, 1101–1102]

OSHA applied the same methods Ms. Wilmer described in this comment and arrived at values similar to the values provided in her testimony, as shown in Table 11.

TABLE 11—SAMPLE INCIDENT-ENERGY CALCULATIONS USING DIFFERENT METHODS

Method	Incident energy (cal/cm²)
Heat flux calculator	3.0 (results must be rounded up to ensure that the protective equipment rating equals or exceeds this value).
Table 8 from proposed Appendix F	5.0.
NFPA 70E–2004, Annex D, section D.7.	152.
NFPA 70E–2004, Table 130.7(C)(9)(a)	Not applicable. Table 130.7(C)(9)(a) lists a Hazard-Risk Category of 2 (8 cal/cm²) for insulated cable examination in open areas, which is an exposure comparable to that of a single-phase arc in open air represented by the Heat Flux calculator and Table 8 from proposed Appendix F. Table 130.7(C)(9)(a) lists a Hazard-Risk Category of 4 (40 cal/cm²) for work on energized parts, which is an exposure comparable to the three-phase arc in an enclosure represented by the method in NFPA 70E–2004, Annex D, section D.7. However, as explained later in this section of the preamble, Table 130.7(C)(9)(a) combines a risk assessment with incident-energy calculation and does not represent incident energy alone.

A closer look at these results shows that the two software programs, heat flux calculator and ARCPRO (upon which OSHA based Table 8 of proposed Appendix F), produce similar results: 3.0 cal/cm² for the heat flux calculator and 5.0 cal/cm² for ARCPRO. Because the arc rating for the lightest weight arc-rated clothing ranges from 4.0 to 5.0 cal/

[299] Table 8 in proposed Appendix F listed estimates of incident energy for different parts of an electrical system operating at 4 to 46 kilovolts. OSHA based these estimates on the ARCPRO method.

[300] NFPA 70E–2004 Table 130.7(C)(9)(a) is a method for selecting PPE based on hazard/risk categories. Proposed Appendix F did not list NFPA 70E–2004, Table 130.7(C)(9)(a), as an acceptable method of estimating incident-energy level.

[301] NFPA 70E–2004, Table 130.7(C)(11) lists the following hazard-risk categories (HRC) with the corresponding minimum required arc ratings: 0–none, 1–4 cal/cm², 2–8 cal/cm², 3–25 cal/cm², 4–40 cal/cm².

cm^2, both programs would lead generally to the use of the same minimum level of protection for the system parameters at issue.[302]

The heat flux calculator and ARCPRO both calculate incident energy produced by single-phase arcs in air, which is clear in the ARCPRO documentation (Ex. 0468). Also, the preamble to the proposal clearly stated that the results from the heat flux calculator require adjustment for application to exposures involving three-phase arcs or arcs in enclosures (70 FR 34867), and other evidence in the record indicates that the calculator is designed for application to single-phase arc exposures (Exs. 0430, 0463).

The incident-energy estimate resulting from application of the formula in NFPA 70E–2004, Annex D, is significantly higher than the results obtained using either of the software programs. There are two reasons for this difference. First, the formula that appears in section D.7 of NFPA 70E, Annex D, is designed to calculate the incident energy produced by a three-phase arc in open air. The corresponding single-phase exposure, based on an ARCPRO conversion factor (multiplying single-phase values by 2.2 to convert them to three-phase values or, conversely, dividing three-phase values by 2.2 to convert them to single-phase values), would be 70 cal/cm^2 (Ex. 0468). Second, although NFPA 70E states that the formula in section D.7 of Annex D can be used to predict the incident energy produced by arcs on systems operating at more than 600 volts, it also explicitly warns about doing so, noting:

> The following example is conservative at voltage levels above 600 volts. Experience suggests that the example is conservative at voltage levels above 600 volts and becomes more conservative as the voltage increases. [Ex. 0134; annex section D.1[303]]

Consequently, it is not surprising that the incident-energy estimate calculated using Annex D of NFPA 70E–2004 for a scenario involving a single-phase arc on a 15-kilovolt system[304] is substantially higher than the values derived using the two software programs.

Ms. Wilmer also mentioned Table 130.7(C)(9)(a) of NFPA 70E–2004. The closest hazard-risk category from Table 130.7(C)(9)(a) is 2 (requiring clothing rated at 8 cal/cm^2), which is for the task of "[i]nsulated cable examination in open air" (Ex. 0134). The other tasks in the category entitled "Other Equipment 1 kV and Above" appear to represent exposures from arcs in enclosures, and all of those tasks, including the one for cable examination, represent three-phase exposures. Moreover, OSHA examined this table more closely and found that it does not represent incident-energy calculations alone. The hazard-risk categories listed in NFPA 70E–2004, Table 130.7(C)(9)(a),[305] include a risk component, as well as an incident-energy component, as can be seen from the entries for the various tasks on 600-volt class motor control centers. The hazard-risk categories for this equipment vary from 1 to 3 (which require clothing rated from 4 to 25 cal/cm^2) depending on the task, even though, according to the notes to the table, the system parameters are the same for all the tasks; thus, the calculated incident energy for all the tasks for this equipment should be the same. While not clear from NFPA 70E–2004, it appears that the NFPA 70E Committee chose to reduce the amount of protection for a task based on the likelihood that an electric arc would occur.[306] The level of protection needed for a particular incident heat energy is the same regardless of the probability that an electric arc will occur. In other words, whether there is a 5-percent risk or a 10-percent risk is not relevant to whether the employee's PPE is adequate. As will be explained later in this section of the preamble, OSHA based the determination of the level of PPE required under the final rule solely on incident heat energy. OSHA's final rule separates the determination of risk (that is, whether an employee is exposed to hazards posed by electric arcs), as required by final paragraph (g)(1), from the calculation of incident energy, as required by final paragraph (g)(2). Therefore, the Agency concludes that NFPA 70E–2004, Table 130.7(C)(9)(a), is not a reasonable method of estimating incident energy under final paragraph (g)(2) and, therefore, is not referencing that table in Appendix E in the final rule.

In the following discussion, the Agency evaluates the various methods listed in Table 10 across three distinct voltage categories (600 volts and less, 601 to 1,000 volts, and more than 1,000 volts), and for each type of electric arc (single-phase arc in open air, three-phase arc in open air, and three-phase arc in an enclosure).

Voltages of 600 volts and less. As can be seen from the tasks listed in Table 130.7(C)(9)(a), much of the work addressed by NFPA 70E–2004 involves voltages of 600 volts or less (Ex. 0134). This category represents the dominant voltage class for utilization equipment installed in buildings, including electric power generation stations. It also includes service-class equipment, such as meters, installed on distribution circuits. There is wide experience using the incident-energy calculation methods included in Annex D of NFPA 70E–2004 and in IEEE Std 1584a–2004,[307] and there is evidence that some electric utilities use these methods successfully (Exs. 0216 (showing TVA's use of IEEE Std 1584 to calculate incident-energy levels), 0444 ("INPO (Institute for Nuclear Power Operations) was and is a huge factor in driving the use of NFPA 70E as a recognized 'best practice' for electrical safety programs in the nuclear power industry")). A national consensus standard recognizes these methods

[302] As explained later in this section of the preamble, Table 6 and Table 7 in Appendix E in the final rule set a minimum level of 4.0 cal/cm^2, which is the minimum level of arc-rated clothing currently available.

[303] NFPA 70E–2012, Annex D, contains the same equation in Section D.6. Similar language warning about conservative results from using the Lee paper for voltages over 600 volts appears in Table D.1, Limitation of Calculation Methods.

[304] Although Ms. Wilmer did not state that her scenario involved a single-phase exposure, her use of Table 8 in proposed Appendix F, the use of which is limited to such exposures, implies that the scenario is for a single-phase arc.

[305] NFPA 70E–2012 contains an equivalent table in Table 130.7(C)(15)(a). As noted earlier, NFPA 70E–2004, Table 130.7(C)(11) lists the minimum arc rating for each hazard-risk category. NFPA 70E–2012 lists minimum arc ratings for each hazard-risk category in Table 130.7(C)(16). OSHA's conclusions regarding NFPA 70E–2004 Table 130.7(C)(9)(a) apply equally to NFPA 70E–2012 Table 130.7(C)(15)(a).

[306] Earlier editions of NFPA 70E, such as the 2000 edition, and NFPA documentation on the adoption of the task table show that the hazard/risk category is reduced by 1 if the probability of an arc is low and reduced by 2 if the probability is very low.

[307] IEEE adopted two amendments after it published IEEE Std 1584–2002: IEEE Std 1584a–2004 (Amendment 1 to IEEE Std 1584–2002), and IEEE Std 1584b–2011 (Amendment 2: Changes to Clause 4 of IEEE Std 1584–2002). (Ex. 0425 contains both the IEEE Std 1584–2002 standard and the 1584a–2004 amendment.) This preamble refers to specific versions of IEEE Std 1584 as follows:

IEEE Std 1584–2002: the base IEEE Std 1584 standard

IEEE Std 1584a–2004: IEEE Std 1584–2002 as amended by IEEE Std 1584a–2004

IEEE Std 1584b–2011: IEEE Std 1584–2002 as amended by IEEE Std 1584a–2004 and IEEE Std 1584b–2011.

IEEE Std 1584a–2004 and IEEE Std 1584b–2011 use the same basic methodology to calculate incident-energy levels as IEEE Std 1584–2002. In this section of the preamble, OSHA analyzed IEEE Std 1584a–2004 (Ex. 0425) to determine whether employers can use that standard to make reasonable estimates of incident energy. The Agency also examined the latest version of IEEE Std 1584 and found that, because the calculation method did not change from IEEE Std 1584a–2004 to IEEE Std 1584b–2011, OSHA's conclusions regarding IEEE Std 1584a–2004 also apply to IEEE Std 1584b–2011, and Appendix E to final Subpart V references IEEE Std 1584b-2011. Unless otherwise noted, the preamble references to the content of IEEE Std 1584a–2004 apply equally to IEEE Std 1584b–2011.

(NFPA 70E),[308] and there is considerable test data validating them (Exs. 0425 ("[the IEEE 1584 committee] has overseen a significant amount of testing and has developed new models of incident energy" and "[IEEE Std 1584a–2004 provides calculations based on] new, empirically derived models based on statistical analysis and curve fitting of the overall test data available"), 0430 (this paper, which the IEEE 1584 committee referenced, reported on the results of 25 tests that supplemented "previously completed extensive arc testing").)

OSHA concludes that the methods of calculating incident heat energy in NFPA 70E–2004, Annex D, and IEEE Std 1584a–2004 are reasonable at voltages of 600 volts and less for the exposures these methods address, as explained more fully later in this section of the preamble. No evidence in the record persuades OSHA otherwise. A paper by Stokes and Sweeting entitled "Electric Arcing Burn Hazards" criticized both the NFPA 70E Annex D and IEEE 1584 methods (Ex. 0452).[309] That paper notes that the NFPA and IEEE methods use a predominantly radiant model of incident heat energy from an electric arc, in which 90 percent of the heat is radiant heat and in which the entire exposure will be outside the electric arc plasma. The Stokes and Sweeting paper disagrees that radiant heat is the predominant hazard and shows that orienting the test electrodes in a horizontal configuration can result in the transference of a greater degree of convective heat and that the amount of heat within the electric arc plasma[310] is more than three times higher than predicted by the NFPA and IEEE models. The Stokes and Sweeting paper also noted that the Lee paper, which is the basis of the NFPA method, predicts a smaller plasma diameter than the plasma diameter found during testing. The Stokes and Sweeting paper explained:

> As an example, for a three-phase arcing exposure of 5000 V and 20000 A, the Lee prediction forecasts a plasma diameter of 170 mm [7 inches]. . . . The authors' test results for this condition, for an arc duration of 0.5 s, show a brilliant plasma cloud some 3000 mm [118 inches] long and around 1500 mm [59 inches] tall in the plane of the camera. [*Id.*]

OSHA recognizes that exposures within the plasma field of an electric arc will produce heat that is several times the incident energy predicted by any of the methods used to calculate heat energy recognized by the final rule. However, the Agency believes that the predominant exposure for employees covered by this final rule will be outside the plasma field. Although, in the Stokes and Sweeting paper, the plasma field extended beyond the distance provided for in the NFPA and IEEE methods, the paper did not indicate how to estimate the field's reach. Furthermore, all of the calculation methods require an estimate of the distance from the electric arc to the employee. The IEEE 1584 method uses 455 to 610 millimeters (18 to 24 inches) for low-voltage (600 volts and less) equipment such as switchboards, panelboards, and motor control centers. As explained later in this section of the preamble, those distances are reasonable estimates of the distance from the employee to the arc. In addition, the testing supporting the IEEE 1584 method, which is representative of typical exposures, confirms the incident-energy results derived using that method (Ex. 0425). There is no evidence in the record that indicates that employees will typically be closer than these distances for this type of work or will be in the plasma field at these working distances. Therefore, OSHA concludes that, in general, the incident-energy calculation methods in NFPA 70E–2004, Annex D, and IEEE Std 1584a–2004 reasonably represent employee exposure for voltages of 600 volts and less.

The IEEE 1584 method accounts for differences between single-phase and three-phase arcs and between arcs in open air and arcs in an enclosure (*id.* ("The arc-flash hazard calculations included in this guide will enable quick and comprehensive solutions for arcs in single- or three-phase electrical systems either of which may be in open air or in a box, regardless of the low or medium voltage available")). In addition, as noted earlier, this method is based on extensive testing, and a consensus standard recognizes this method. Therefore, OSHA concludes that this method reasonably represents employee exposures for single-phase and multiphase arcs in enclosures and open air.

Proposed Appendix F also listed a paper by Doughty, Neal, and Floyd as a method of estimating incident energy from an electric arc. (See Table 10 earlier in this section of the preamble.) This paper describes the results of tests performed on a 600-volt power system with a 36.25-kiloampere prospective fault current and contains algorithms to estimate incident energy at a specified distance from an arc as a function of the available bolted-fault current on a 600-volt system (Ex. 0430). The tests included three-phase arcs in enclosures and in open air (*id.*). Because this paper was peer reviewed and the methods it uses are based on testing electric arcs, OSHA finds that the method in this paper reliably estimates incident energy for the 600-volt systems it represents.[311] The Agency also finds that it reasonably represents incident energy for systems of lower voltages and for single-phase systems because the power produced by these systems should be comparable to, and not exceed, the power from a three-phase 600-volt system with an equivalent supply. The Doughty, Neal, and Floyd method will produce conservative results for lower-voltage and single-phase systems. On the other hand, this method does not estimate incident energy for systems of higher voltages. Therefore, OSHA finds that it is not reasonable to use this method to estimate incident energy for systems of voltages of more than 600 volts.

The Doughty, Neal, Floyd paper compared the results of its authors' testing with other methods of estimating incident-energy levels, including the NFPA Annex D method, the heat flux calculator, and a commercial software program (apparently ARCPRO), which OSHA listed in the proposal (*id.*). The paper compared the incident energy it found for three-phase electric arcs with the incident energy calculated by the Lee equation used in NFPA 70E, Annex D, by examining the distance required to achieve an incident-energy level of 1.2 cal/cm^2. This distance is the "curable burn distance," which is the distance at which an employee will begin to sustain a second-degree, or curable, burn. The paper explained the results of this comparison as follows:

> The Lee "curable burn" distances coincide almost exactly with the second-degree burn distances for the open three-phase arc. The second-degree burn distances for the arc in the cubic box, however, are significantly higher. The difference is more pronounced at higher bolted fault levels. [*id.*]

Figure 8 depicts these functions.

[308] As previously mentioned, NFPA 70E–2004, Annex D, recognizes IEEE Std 1584–2002 as a valid method of calculating incident heat energy (Ex. 0134).

[309] Stokes, A. D., Sweeting, D. K., "Electric Arcing Burn Hazards," IEEE Transactions on Industry Applications. Vol. 42. No. 1, January/February 2006. pp. 134–141.

[310] Plasma is the high-temperature ionized gas cloud that results from the electric arc.

[311] The equations given in this paper are for an arc lasting 6 cycles. An employer using the Doughty, Neal, and Floyd method will need to adjust the results to account for any clearing times different from 6 cycles by multiplying the incident energy calculated using these equations by the ratio of the actual clearing time to 6 cycles.

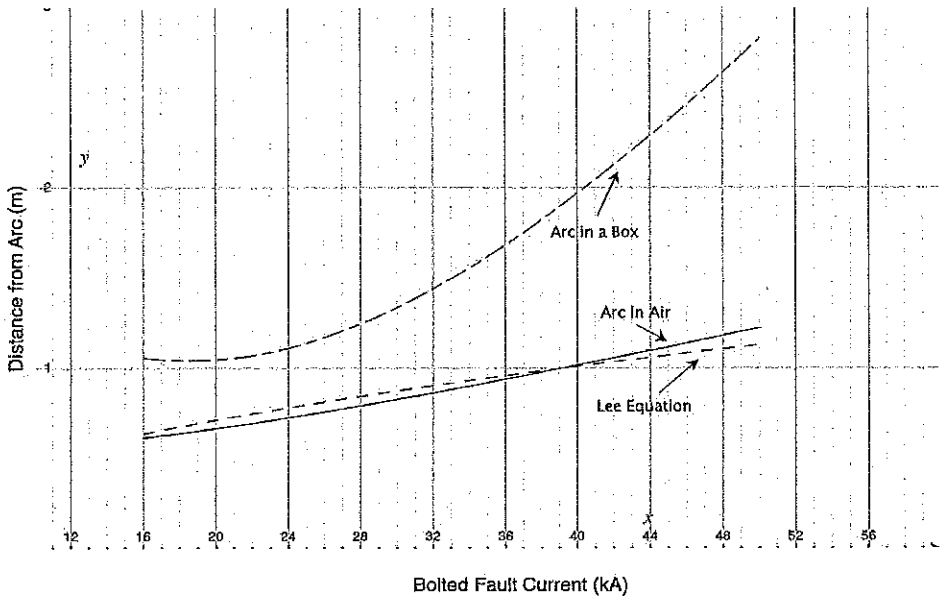

Figure 8--Curable Burn Distance

Based on this analysis, the Agency finds that the Lee equation from NFPA 70E–2004, Annex D, is a reasonable method of estimating the incident energy of a three-phase electric arc in open air for systems of 600 volts or less. However, because the Lee equation significantly underestimates incident energy from three-phase arcs in an enclosure, OSHA finds that this is not a reasonable method to estimate incident energy from such exposures. The Agency also finds that the NFPA 70E–2004, Annex D, method reasonably represents incident energy for single-phase systems because the power produced by these systems should be comparable to, and not exceed, the power from a three-phase system with an equivalent supply. Thus, this method will produce conservative results for single-phase systems.

The Doughty, Neal, and Floyd paper also compared the results of its authors' testing with the heat flux calculator and "a commercially available computer program" (*id.*).[312] The paper found that:

- The three-phase test values of maximum incident energy for open arcs were 2.5 to 3.0 times the amounts calculated for single-phase arcs in air by the two programs; and
- The three-phase test values of maximum incident energy for arcs in a box were 5.2 to 12.2 times the amounts calculated for single-phase arcs in air by the two programs (*id.*).

This comparison clearly shows that neither program reasonably estimates incident heat energy from three-phase electric arcs or electric arcs in an enclosure. Although there are conversion factors recommended for these programs, these conversion factors do not account for the wide variation between the incident energies the programs calculate and the actual incident energy found during testing. Thus, OSHA finds that the heat flux calculator and ARCPRO do not reasonably estimate incident heat energy for three-phase arcs or arcs in a box for systems of 600 volts or less.

On systems of 600 volts or less, the phase conductors are typically relatively close together, approximately 30 millimeters (1.25 inches), as noted in the Doughty, Neal, and Floyd paper (*id.*). When an arc occurs between one phase and ground, or between two phases, the surrounding air becomes ionized (and, thus, conductive), and it can relatively easily escalate to a three-phase arc (Ex. 0425). In addition, as seen from NFPA 70E–2004, Table 130.7(C)(9)(a), most of the exposures at this voltage level, with the exception of work on service drops, involve equipment in enclosures (Ex. 0134).[313] Consequently, OSHA concludes that it normally would be unreasonable to estimate incident-energy levels for systems of 600 volts using methods based on single-phase open air arcs. However, the employer may use such methods when it can demonstrate that there is only one phase present or that the spacing of the phases is sufficient to prevent the formation of a three-phase arc. The incident energy results from the electric-arc model used by ARCPRO "have shown good agreement with measured values from a series of tests covering the following ranges of parameters: Currents from 3.5 kA to 21.5 kA, arc durations from 4 cycles to 30 cycles, arc lengths from 1 inches to 12 inches, and distances of 8 inches to 24 inches from the arc" (Ex. 0469). The ARCPRO documentation does not indicate the voltage range verified by the test results; however, the model used by this program uses voltage only to ensure that an arc can be sustained over the distance between electrodes. Consequently, OSHA finds that this program can reasonably estimate incident energy from a single-phase arc in open air for systems of 600 volts or less, and the employer may use the program as long as the employer can demonstrate that there is only one phase present or that the spacing of the phases is sufficient to prevent the formation of a three-phase arc.

For reasons explained later in this section of the preamble, OSHA finds that the heat flux calculator is not a reasonable method for estimating incident energy for any type of exposures, irrespective of voltage.

[312] Although the paper did not identify the "commercially available computer program" by name, OSHA closely examined the results from ARCPRO and compared them with the commercial software program incident-energy estimates reported by the paper and found them to be equivalent.

[313] OSHA acknowledges that NFPA 70E exempts work on electric power generation, transmission, and distribution installations. However, the electric equipment installed in generating plants is of the same type as that covered by NFPA 70E (Ex. 0077), and OSHA concludes that the tasks performed on this equipment would be of a similar nature.

Table 12 summarizes OSHA's findings regarding the reasonableness of using the various methods of estimating incident heat energy for exposures involving single-phase and three-phase arcs in open air and in an enclosure for voltages of 600 volts and less.

Voltages of 601 volts to 15 kilovolts. Work at voltages from 601 volts to 15 kilovolts is common to both electric power distribution work and to work in industrial and electric utility substations and plants. Industrial installations use equipment similar to that used by electric utilities (see, for example, 59 FR 4333–4334). Therefore, any method that is appropriate for use with industrial systems operating at these voltages should be appropriate for use with electric power generation and distribution installations.

Again, there is wide experience using the incident-energy methods included in Annex D of NFPA 70E–2004 and in IEEE Std 1584, and there is evidence that some electric utilities use these methods successfully (Exs. 0216, 0444). A national consensus standard (NFPA 70E) recognizes these methods, and there is considerable test data validating them (Exs. 0425, 0430). OSHA, therefore, finds that the IEEE 1584 method reasonably estimates incident-energy levels for systems operating at voltages of 601 volts to 15 kilovolts for exposures involving single-phase and three-phase arcs in open air or in enclosures. As explained previously in the discussion of Ms. Wilmer's comments, the method in NFPA 70E, Annex D (the Lee method), is conservative at more than 600 volts. In addition, this method estimates incident-energy levels for three-phase arcs and, thus, is even more conservative for exposures involving single-phase arcs. Because the NFPA 70E Annex D method is conservative, OSHA finds that it reasonably estimates incident-energy levels for systems operating at voltages of 601 volts to 15 kilovolts, that is, it will provide employees with adequate protection.[314] However, clothing appropriate for the levels of incident energy calculated by the NFPA 70E Annex D method will be heavier and bulkier, as well as more expensive, than clothing appropriate for incident energy calculated using other acceptable methods. (See, for example, Ex. 0213, "[The NFPA 70E Annex D method] could be used to calculate incident energies for transmission system voltages, but [it] will produce very conservative (high heat energy) results. This will result in employees wearing unnecessarily heavy arc flash protection when working on lines.") Consequently, the Agency anticipates that employers will only use this method to estimate incident-energy levels at voltages of 601 volts to 15 kilovolts when it would result in the use of clothing with a relatively low arc rating.

The method in the Doughty, Neal, and Floyd paper described earlier in this section of the preamble is based on testing performed exclusively with an electrode spacing of 32 millimeters (1.25 inches) at 600 volts (Ex. 0430). There is no evidence in the record that suggests that this method is suitable at higher voltages, at which electrode gaps likely are significantly longer. Therefore, OSHA finds that this method does not reasonably estimate incident-energy levels for systems operating at voltages above 600 volts.

The Agency closely examined the two software calculation methods, ARCPRO and the heat flux calculator, over the voltage range 601 volts to 15 kilovolts. OSHA performed this examination in part by looking at the estimates of heat flux for different system parameters. Heat flux is a measure of the flow of heat energy per unit area per second. The incident energy from an electric arc can be computed by multiplying the heat flux, which has the units cal/cm^2-sec, by the number of seconds the arc lasts (that is, the clearing time or the amount of time the devices protecting a circuit take to open the circuit). The clearing time for circuit protective devices typically is given in cycles, which then is converted to seconds by dividing the number of cycles by the number of cycles per second, usually 60. The two software programs, ARCPRO and the heat flux calculator, can be used to calculate the heat flux at a given distance from an electric arc with varying parameters (for example, arc length, system voltage, and current). Figure 9 compares the heat flux calculated by these two programs at 380 millimeters (15 inches) from an arc with an electrode spacing of 51 millimeters (2 inches).[315] Note that, although 15 kilovolts is the voltage input to these programs, the incident energy calculated by both programs would be the same at 601 volts. The two programs only use the voltage to verify that an arc can be sustained across the given electrode gap. Figure 9 shows that the heat flux calculator produces results that can be more than 50 percent less than the results produced by ARCPRO.

After calculating the incident heat energy using ARCPRO or the heat flux calculator, an employer can select arc-rated protective equipment. NFPA 70E–2004 contains a widely used, five-level system for selecting protective clothing based on different incident-energy levels (Ex. 0134). Figure 10 shows the protective-clothing arc rating, based on the NFPA 70E levels, that employers would select based on the heat-flux results shown in Figure 9 for each software program using clearing times of 6, 12, and 36 cycles. The figures clearly show that incident-energy calculations from the heat flux calculator can be more than 50 percent lower than the calculations from ARCPRO. This difference generally increases with increasing fault current.

The documentation for ARCPRO describes the formulas for calculating energy and heat estimates and the basis for that program's formulas, as follows:

> The ARCPRO computer program is based on a state-of-the-art electrical arc model . . . Temperature-dependent gas properties, the electrode materials and configuration are taken into account in the model . . .
>
> Energy and heat values computed by ARCPRO have been verified by comparison with measured results from high current laboratory tests involving controlled vertical arcs in air. ARCPRO results have shown good agreement with measured values from a series of tests covering the following ranges of parameters: Currents from 3.5 kA to 21.5 kA, arc durations from 4 cycles to 30 cycles, arc lengths from 1 inches to 12 inches, and distances of 8 inches to 24 inches from the arc. [Ex. 0469]

Ontario Hydro Technologies (now known as Kinectrics), the same company that performs high-voltage and high-current electrical testing, including arc testing, developed this program for numerous purposes. (See, for example, Exs. 0469, 0501; Tr. 283.[316]) Consequently, OSHA concludes that the incident-energy values calculated by this program relate reasonably to the heat energy faced by employees facing exposures involving single-phase electric arcs in open air. (As explained previously, ARCPRO's conversion factors for exposures involving three-phase arcs and arcs in enclosures do not reasonably estimate employee exposures and would result in significant underprotection for workers.) The Agency believes that this program is highly accurate over the range of input parameters for which testing validated the results, that is, single-phase arcs in

[314] For reasons already explained, the NFPA 70E Annex D method is not reasonable for estimating incident energy exposures from three-phase arcs in an enclosure.

[315] In preparing Figure 9, OSHA used the values from Table 6 in Appendix E for the distance to the arc and the electrode spacing corresponding to 15 kilovolts.

[316] See also *http://www.kinectrics.com/en/serviceline/ElectricalTesting.html.*

open air only. Therefore, OSHA finds that ARCPRO reasonably estimates incident-energy levels for single-phase arcs in open air for systems operating at 601 volts to 15 kilovolts.

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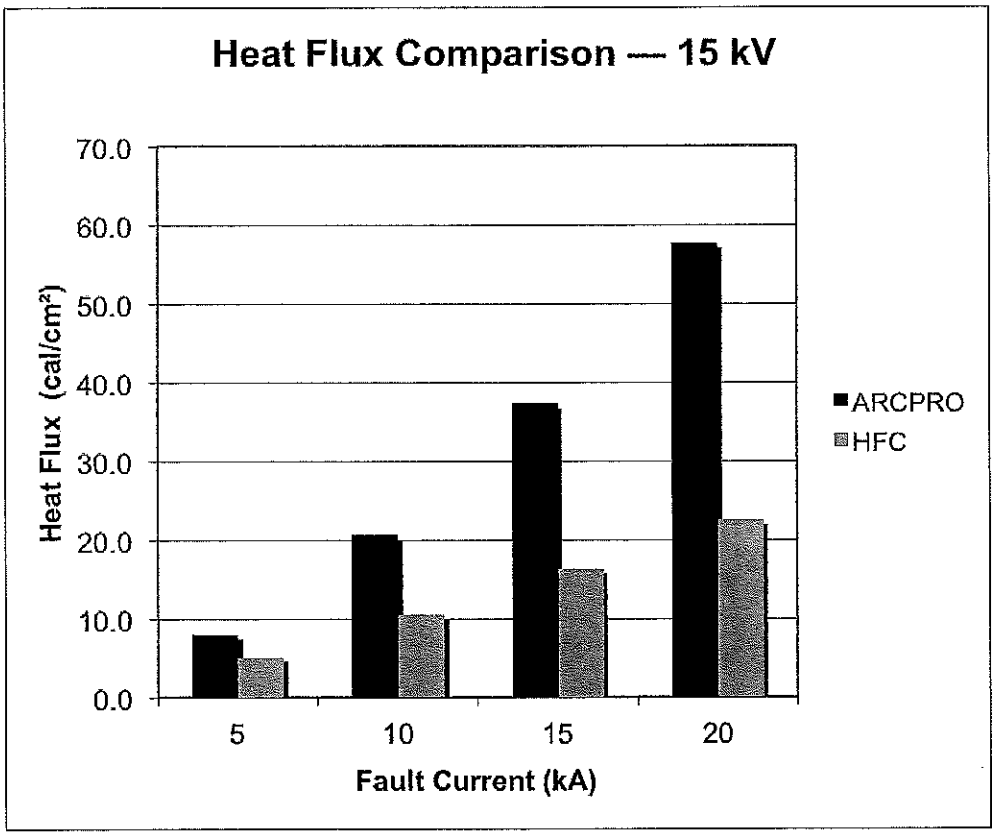

Figure 9—Heat Flux Comparison—ARCPRO and Heat Flux Calculator (HFC)

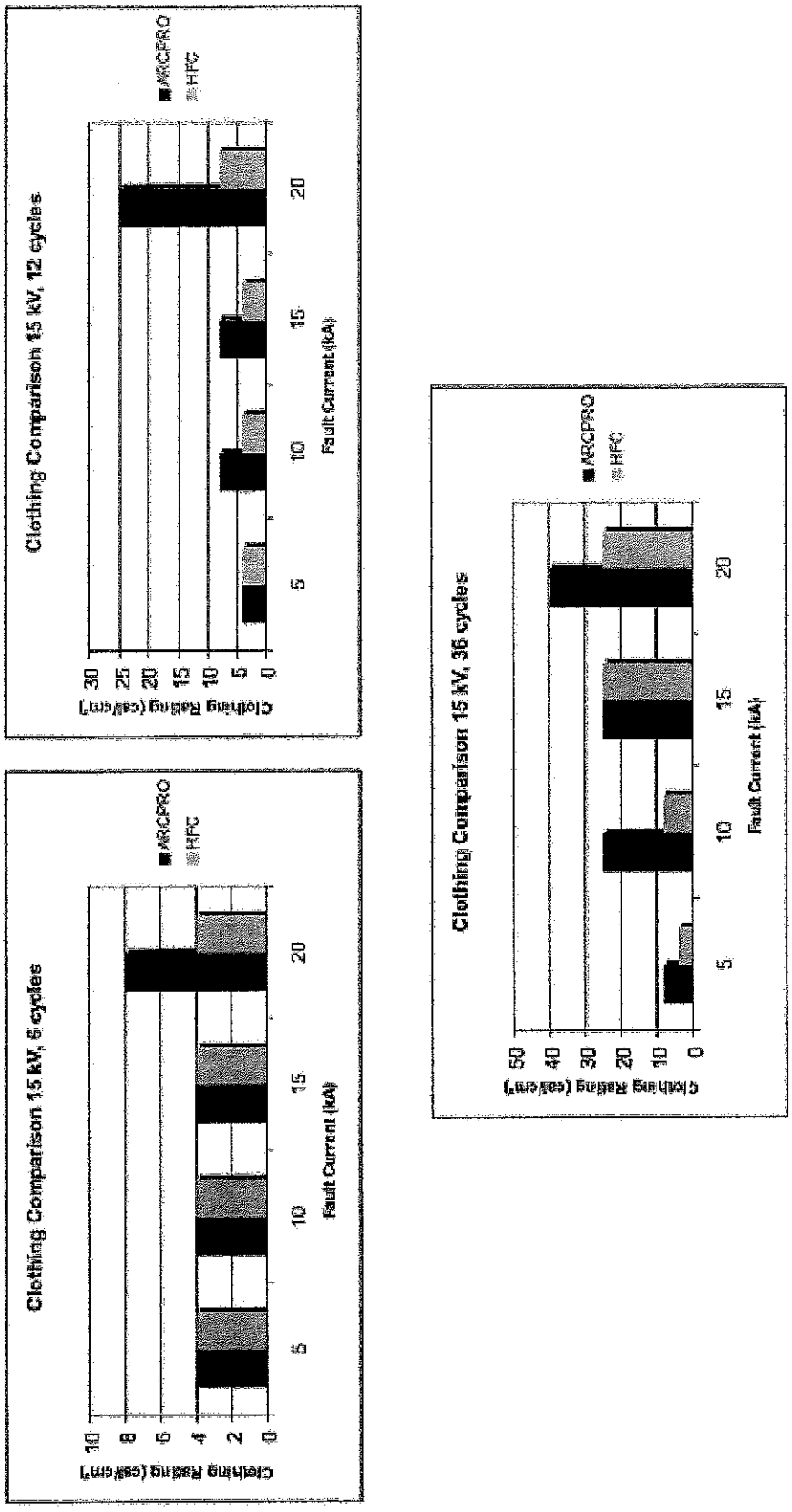

Figure 1—Comparison of Clothing Level Selection Based on ARCPRO and Heat Flux Calculator (HFC)

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On the other hand, there is little documentation supporting use of the heat flux calculator beyond the documentation provided by the NASCO Electric Arc Hazard Support Page, which describes the program (Ex. 0467).[317] OSHA is aware that some employers, electric utilities and others, use this program to estimate incident-energy levels and select appropriate PPE (Ex. 0430). However, there is little information in the record on which to judge the heat flux calculator on its own merits or the results it produces. In fact, TVA commented that it is "not aware of any test verification of the results derived from the Heat Flux Calculator" (Ex. 0213). Because the heat flux calculator provides incident-energy levels that are substantially below the levels resulting from the testing that supports ARCPRO and because there is no other means of validating the incident energy results from this program, OSHA cannot find that the heat flux calculator reasonably estimates incident heat energy levels for any exposures covered by this final rule.

Table 12 summarizes OSHA's findings regarding the reasonableness of using the various methods of estimating incident heat energy for exposures involving single-phase and three-phase arcs in open air and in an enclosure for voltages of 601 volts to 15 kilovolts.

OSHA expects employers to determine the type of exposure employees will face. If the energized parts are not in an enclosure, the employer may use a method appropriate for single-phase arcs in open air as long as the employer can demonstrate that there is only one phase present or if the spacings of the phases is sufficient to prevent the formation of a three-phase arc. Otherwise, employers must use a method suitable for three-phase arcs in open air or in an enclosure, as appropriate.

Voltages of more than 15 kilovolts. Systems that operate at more than 15 kilovolts generally are electric power distribution or transmission systems covered by existing § 1910.269 and subpart V. Although some industrial plants operate systems at these voltages, these existing OSHA standards typically cover systems operating at more than 15 kilovolts regardless of whether an electric utility or an industrial operation operates the system. (See, for example, the preamble to the 1994 final rule adopting existing § 1910.269 (59 FR 4333–4335).)

IEEE Std 1584a–2004 describes the limits of its application as follows:

This model is designed for systems having:

—Voltages in the range of 208 V–15 000 V, three-phase.

* * * * *

Use of this model is recommended for applications within the parameters stated in this subclause. [Ex. 0425]

Systems operating at voltages above 15 kilovolts are, thus, outside the recommended range of applications for the IEEE standard. Consequently, OSHA finds that the IEEE 1584 method does not reasonably estimate incident-energy levels for systems operating at voltages of more than 15 kilovolts.

As noted earlier, the NFPA 70E Annex D method gives conservative results for voltages over 600 volts. For example, as explained in the discussion of Ms. Wilmer's comment earlier in this section of the preamble, that method produces an incident heat energy level of 152 cal/cm² for an exposure involving a three-phase arc in open air for a system of 15 kilovolts with a fault current of 5,000 amperes, a clearing time of 34.5 cycles, and a distance from the employee to the arc of 381 millimeters (15 inches). In addition, the NFPA 70E Annex D method produces an incident-energy level of 1254 cal/cm² for an exposure involving a three-phase arc in open air for a system of 800 kilovolts with a fault current of 20,000 amperes, a clearing time of 54.5 cycles, and a distance from the employee to the arc of 2,200 meters (86.6 inches).[318] These values are too high to be meaningful, particularly at the higher end of the voltage range. Employers using the NFPA 70E Annex D method to select arc-rated clothing would outfit employees in clothing that exposes employees to severe heat-stress hazards even though the incident energy is not high enough to warrant such protection. Thus, OSHA finds that it is not reasonable to use this method to estimate incident energy for systems of voltages of more than 15 kilovolts. However, in some cases, employees may be far enough away from any potential arc that even the NFPA 70E Annex D method does not result in an estimated incident energy that is sufficient to ignite flammable clothing (2.0 cal/cm² or less, as explained later in this section of the preamble). Because that method is conservative, employers may use it to determine that employee exposure to estimated incident-heat energy is not more than 2.0 cal/cm² and, thus, that employees need not wear FR clothing under final paragraph (g)(4)(iv).

For reasons explained previously, OSHA finds the Doughty, Neal, and Floyd method does not reasonably estimate incident energy for systems at voltages of more than 600 volts.

OSHA compared incident-energy values evaluated by the heat flux calculator to the values computed by ARCPRO at voltages higher than 15 kilovolts using parameters from Table 8 and Table 9 of proposed Appendix F. The results of this comparison were similar to the results of the comparison using voltages of 601 volts to 15 kilovolts described earlier. The incident energies computed by the heat flux calculator were substantially lower than the results computed by ARCPRO using the same parameters for systems of more than 15 kilovolts. In addition, as noted earlier, there is no information in the record validating the incident-energy results obtained using the heat flux calculator. Therefore, OSHA concludes that the heat flux calculator does not reasonably estimate incident energy from systems of more than 15 kilovolts.

As noted earlier, verification of the ARCPRO incident-energy calculation model occurred by testing a wide range of input parameters (Ex. 0469). This model is mostly independent of voltage (in other words, the results do not vary with voltage); the program only checks that the voltage will sustain an arc across the electrode gap (*id.*). The program accepts parameters outside the range verified by testing,[319] and there is no evidence in the record to indicate that results using parameters outside that range would be invalid (*id.*). As noted earlier, this program calculates incident energy from a single-phase arc in open air. OSHA concludes that this program accurately calculates incident heat energy from such arcs. Therefore, the Agency finds that ARCPRO reasonably estimates incident energy from single-phase arcs in open air on systems of more than 15 kilovolts.

As mentioned previously, the incident energy calculated by ARCPRO was significantly less than the actual heat energy found when testing 600-volt, three-phase arcs in open air and in an enclosure (Ex. 0430). Regardless of voltage, three-phase arcs consume more power and, therefore, produce more energy, and three-phase arcs in an enclosure produce even more heat energy because the heat energy radiating away from the worker reflects back towards the worker and because all of the convective heat energy is directed toward the worker (Exs. 0430, 0433).[320] Therefore, OSHA concludes that using unmodified ARCPRO results would significantly underestimate the amount of incident heat energy from these exposures. ARCPRO provides multiplication factors for adjusting the results to estimate incident energy from three-phase arcs in open air and

[317] The updated online version of this page contains a link to download the free program (*http://www.nascoinc.com/quick_links/heatflux.htm*). The program is also available on other Internet Web sites.

[318] Table 9 in proposed Appendix F listed incident heat energies for various voltage ranges of more than 46 kilovolts and fault currents. These are the values for the distance to the arc and the electrode spacing used in that table for 765 to 800 kilovolts. The corresponding table in the final rule (Table 7 of Appendix E) has been revised, as explained later in this section of the preamble, but those parameters are the same for that voltage range.

[319] "ARCPRO results have shown good agreement with measured values from a series of tests covering the following ranges of parameters: currents from 3.5 kA to 21.5 kA, arc durations from 4 cycles to 30 cycles, arc lengths from 1 [inch] to 12 inches, and distances of 8 inches to 24 inches from the arc" (Ex. 0469).

[320] Convection occurs in fluids (liquids and gases) through the mixing of hot and cold fluid regions driven by pressure, gravity, or mechanical agitation. This is the type of heating that occurs as a pot of water is heated to boiling on a stove. Thermal radiation occurs when radiation (such as infrared radiation) is emitted from an object and is absorbed by another object. This is the type of heating provided by the sun.

in enclosures.[321] However, the Agency found that those adjustments were not reasonable for systems up to 15 kilovolts. In those cases, there are alternative calculation methods, identified in Table 12, that more accurately estimate incident energy for those exposures. In contrast, there is no reasonable alternative for voltages of more than 15 kilovolts. Therefore, because ARCPRO is the best available technology for estimating incident energy for three-phase arcs in open air and in an enclosure for systems operating at more than 15 kilovolts, OSHA will treat this program as reasonably estimating incident energy for these exposures provided the employer adjusts the results using the conversion factors in the instructions included with the program.

Mr. Tommy Lucas with TVA maintained that there are no nationally recognized methods of reasonably estimating incident energy over 60 kilovolts (Ex. 0213).

As noted previously, however, OSHA evaluated the ARCPRO computer-software method and found that it provides a reasonable estimate of incident energy for voltages above 15 kilovolts, including voltages of more than 60 kilovolts.

Table 12 summarizes OSHA's findings regarding the reasonableness of using the various methods of estimating incident heat energy for exposures involving single-phase and three-phase arcs in open air and in an enclosure for voltages higher than 15 kilovolts.

Underground exposures, internal transformer faults, and other potentially high exposures. Consolidated Edison Company of New York (Con Edison), commented that the methodologies included in the proposal would not be useful for exposures faced by its employees, explaining:

> Con Edison has spent millions of dollars to recreate real life fault situations on our system at a high power testing laboratory. In these recreation scenarios we deliberately caused cable faults both in open air and in manholes and had mannequins wired with heat sensors to measure the incident energies our employees could potentially be exposed to. Based on the experience gained through thousands of these faults, both open air and in manholes, we realized that none of the methodologies OSHA now proposes would be useful in conducting an analysis to arrive at a protective scheme for our employees. [Ex. 0157]

Although Con Edison did not provide the results of its tests, Dr. Mary Capelli-Schellpfeffer submitted a presentation that Con Edison prepared describing the company's tests (Ex. 0371). This presentation did not include any quantitative comparisons with OSHA's proposed methods of estimating incident energy. However, it did indicate that Con Edison was able to select appropriate protective garments that "have proven to be effective in the protection of [its employees]" (*id.*).

The company's tests included tests of faulted transformers and cable faults in manholes, and OSHA acknowledges that it is possible for the incident energy for these exposures to exceed results obtained using the IEEE 1584 method, which addresses exposures involving three-phase arcs in both open air and enclosures.[322] If a transformer experiences an internal fault, the transformer oil can ignite, and the burning oil will contribute additional heat energy not accounted for by that method (Ex. 0004).[323] For underground exposures in manholes and vaults, it is possible not only for the wall of the enclosure close to the arc to reflect the heat energy, but for the far walls to do so as well. The IEEE 1584 method accounts for the former but not the latter reflections (Ex. 0425). Because the IEEE 1584 method, if the voltage is 15 kilovolts or less, and ARCPRO, if the voltage exceeds 15 kilovolts, are the best available methods for estimating incident energy for three-phase arcs in open air or in enclosures, OSHA will treat those two methods as reasonably estimating incident energy for the exposures cited by Con Edison. However, these estimates may not fully protect employees from electric-arc exposures resulting from internal faults in transformers or similar equipment or from arcs in underground manholes or vaults. Despite this shortcoming, the Agency believes that using these methods to estimate incident energy and to select appropriate protective equipment in accordance with the other provisions of final paragraph (g) will better protect employees than if employers permitted employees to work without arc-rated protective equipment. (See, also, the summary and explanation of paragraph (g)(5), later in this section of the preamble.)

Manipulation of results. Some rulemaking participants maintained that employers could manipulate the estimate of incident energy by selecting an inappropriate calculation method or by varying the parameters, such as arc length or distance from the arc, to achieve desired results. (See, for example, Exs. 0156, 0161, 0183.) Others commented more generally that the results of incident-energy calculations will vary depending on the parameters selected. (See, for example, Exs. 0163, 0173, 0181.) For instance, Mr. Alan Blackmon with Blue Ridge Electric Cooperative commented:

> Estimates of maximum amounts of heat energy to which an employee would be exposed require making so many subjective assumptions as to render the calculations useless. OSHA therefore should drop this requirement. There is no value in an estimation that so easily can be manipulated through choosing of, for example, duration of arc and distance from arc to employee. [Ex. 0183]

The parameters used by the calculation methods discussed earlier include: the fault current (usually the maximum available fault current), the system voltage, the arc length, the arc duration, and the distance from the arc to the employee.[324] The system fixes most of these parameters. Each system has a fixed system voltage, fault current, and fault clearing time.[325] The system voltage is a known "quantity." IEEE Std 1584a–2004, Section 4.4, explains the calculation of the maximum fault current based on known characteristics about the circuit involved (Ex. 0425). IEEE Std 1584a–2004 describes how to determine the corresponding fault-clearing time by checking the maximum fault current against the time characteristics provided by the protective device manufacturer as follows:

> An arc-flash hazard analysis should be performed in association with or as a continuation of the short-circuit study and protective-device coordination study. The process and methodology of calculating

[321] Here are the conversion factors listed in ARCPRO's help system:

Energy for:	Multiply by:
1-phase in a box....	1.5
3-phase.....	1.2 to 2.2
3-phase in a box....	3.7 to 6.5

(Ex. 0468).

[322] Because Con Edison did not provide the parameters involved in its tests, OSHA cannot determine for certain what the exposure was. However, the Agency assumes that the manhole and cable testing was performed with three-phase voltages between 601 volts and 15 kilovolts. From Table 12, the IEEE 1584 method is the only method that provides a reasonable estimate for three-phase arcs in an enclosure, which is the exposure most common in manholes; and the IEEE 1584 and NFPA 70E Annex D methods are the only methods that provide a reasonable estimate for three-phase arcs in open air, which is the exposure associated with three-phase cables.

[323] See, for example, the two accidents described at *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=170632699&id=14343594.*

[324] IEEE Std 1584a–2004 also expects the user to select the overcurrent device protecting the circuit (Ex. 0425). However, that method makes certain assumptions about some of the other parameters, in particular, arc duration, that avoid the need to enter those parameters. The consensus standard also provides a generic case in which all of the typical parameters are input. IEEE Std 1584b–2011 provides additional guidance on selecting arc-duration times for different types of overcurrent protective devices (that is, fuses, integral-trip circuit breakers, and relay-operated circuit breakers) for the generic case.

[325] The arc will last until the protective device opens the circuit. Thus, the fault clearing time equals the duration of the arc.

short-circuit currents and performing protective-device coordination is covered in IEEE Std 141–1993 (IEEE *Red Book*™) and IEEE Std 242–2001 (IEEE *Buff Book*™), respectively. Results of the short-circuit study are used to determine the fault current momentary duty, interrupting rating, and short-circuit (withstand) rating of electrical equipment. Results of the protective-device coordination study are used to determine the time required for electrical circuit protective devices to isolate overload or short-circuit conditions. Results of both short-circuit and protective-device coordination studies provide information needed to perform an arc-flash hazard analysis. [*id.* [326]]

Engineers typically perform system coordination studies during the design of the system and again periodically and after any significant change to the system (Tr. 1030–1031). If no initial or periodic studies take place, the system owner risks having a fault on one part of the system cause an outage over an extended portion of the system instead of having the fault confined to the affected circuit. (See, for example, 269-Exs. 8–15, 8–16, 8–17, 8–20, 8–21, 8–22.) As required by existing § 1910.269(n)(4)(i), employers must ensure that a similar engineering analysis is performed to determine the appropriate ampacity for protective grounding equipment; this provision specifies that protective grounding equipment must be "capable of conducting the maximum fault current that could flow at the point of grounding for the time necessary to clear the fault." As noted by Mr. James Tomaseski of IBEW: "For . . . employees to install personal protective grounds on a circuit, they need to establish what level of . . . fault currents are available, and that will decide what size grounds they will install" (Tr. 960). Consequently, OSHA concludes that employers are likely to have information that the Agency can verify about the system voltage, fault current, and clearing times. OSHA will deem any manipulation of these parameters for purposes of estimating heat energy under final paragraph (g)(2) to result in an unreasonable estimate of incident energy in violation of the standard.

Table 8 in proposed Appendix F presented estimates of available energy for different parts of an electrical system operating at 4 to 46 kilovolts. Table 9 of proposed Appendix F presented similar estimates for systems operating at voltages of 46.1 to 800 kilovolts. These tables were for open-air, phase-to-ground (that is, single-phase) electric-arc exposures typical for overhead systems operating at these voltages. Table 8 and Table 9 of proposed Appendix F provided information on what OSHA would consider as reasonable estimates of arc length and the distance from the arc to the employee, as described later in this section of the preamble. OSHA revised these tables as described later in this section of the preamble and included them in the final rule as Table 6 and Table 7 of Appendix E. OSHA will consider it reasonable for an employer to use the Table 6 and Table 7 estimates of arc length and the distance from the arc to the employee—for single-phase arcs in open air—for purposes of the calculations required by final paragraph (g)(2). IEEE Std 1584a-2004 also provides guidance on these parameters (Ex. 0425).

Reasonable estimates of the arc gap (arc length). As noted earlier, the exposures covered by Table 6 and Table 7 of Appendix E of final subpart V, that is single-phase arcs in open air, typically occur during overhead line work. In this case, the arc will almost always occur when an energized conductor approaches too close to ground. Thus, employers can determine the arc gap, or arc length, for these exposures by the dielectric strength of air and the voltage on the line (Exs. 0041, 0533).[327] The dielectric strength of air is approximately 10 kilovolts for every 25 millimeters (1 inch) (Ex. 0041), with a minimum arc gap of 51 millimeters (1 inch). For example, at 50 kilovolts, the arc gap would be 50 ÷ 10 × 25, or 125 millimeters (5 inches). Although OSHA is providing this guidance in the final rule, as discussed later in this section of the preamble, employers may use other estimates of the arc gap for single-phase arcs in open air if the estimates reasonably resemble the actual exposures faced by employees.

For three-phase arcs in open air and in enclosures, the IEEE 1584 method provides guidance (Ex. 0425). That method does not require the user to input an arc gap (*id.*). Instead, it incorporates the arc gap into its calculations based on the class of equipment involved. The user selects the type of equipment involved (for example, 600-volt switchgear). It then uses the appropriate bus or conductor spacings in that equipment as the arc gap in the calculation of incident energy. For a three-phase arc to occur, current must arc between all of the phases. Such arcs typically occur when a conductive object drops across the phases or when there is an internal fault in the equipment; therefore, OSHA concludes that it is reasonable to use the bus or conductor spacing as the arc gap. Notably, neither the NFPA 70E Annex D nor the Doughty, Neal, and Floyd method require users to input an arc gap.

Reasonable estimates of the distance from the employee to the arc. All of the acceptable methods of estimating incident energy require the user to input the distance from the arc to the employee. This approach requires some judgment by the employer. However, the hazard assessment required by final paragraph (g)(1) will provide information that the employer can use to assess where arcs are reasonably likely to occur in relation to the employee. To determine employee exposure to hazards from electric arcs as required by final paragraph (g)(1), the employer must determine where an employee is reasonably likely to be when an arc occurs (in addition to whether there is a reasonable likelihood that an arc could occur in the first place).

In Appendix E to final subpart V, OSHA provides guidance on distance assumptions it will consider reasonable for estimating incident energy for exposures involving single-phase arcs in open air. As noted earlier, work on overhead power lines typically exposes employees to single-phase arcs in open air. Employees performing this type of work handle conductors; and these conductors can contact a grounded object, or a grounded conductor (such as a guy or grounding jumper) can contact a phase conductor (Ex. 0004 [328]).

[326] IEEE Std 1584b-2011 revises this paragraph and separates it into five paragraphs. The revisions are editorial, except for updated references to relevant IEEE standards, including the substitution of IEEE Std 551™-2006 (IEEE *Violet Book*™) for IEEE Std 141–1993 (IEEE *Red Book*™), and additional language explaining that "electrical system analysis software may be used to simplify the calculations for complex distribution systems . . ." and explaining the limitations and advantages of such software.

[327] Table 6 of Appendix E of final subpart V uses a more conservative arc gap that equals the electrical component of the minimum approach distance rather than a value corresponding to the dielectric strength of air for the system voltage. (See the summary and explanation for final § 1926.960(c)(1), earlier in this section of the preamble, and Appendix B to final Subpart V for additional information on determining the electrical component of the minimum approach distance based on the maximum transient overvoltage for a system and determining the dielectric strength of air for the maximum phase-to-ground system voltage.) OSHA used the electrical component of the MAD to create Table 6 in final Appendix E for consistency with the approach used in similar tables in the 2007 NESC (Ex. 0533) and the 2012 NESC.

[328] See, for example, the six accidents described at *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=170805238&id=200021004&id=170070981&id=201791803&id=142918688&id=170178370.*

As noted under the summary and explanation for final paragraph (c)(1), earlier in this section of the preamble, much of the work performed on energized parts operating at 46 kilovolts and less is done by employees using rubber insulating gloves.[329] Working in a comfortable position with elbows bent, an employee would be approximately 380 millimeters (15 inches) from the energized conductor on which he or she is working, measured from the employee's chest.[330] Thus, OSHA used a distance of 380 millimeters (15 inches) to calculate the incident-energy values in Table 8 in proposed Appendix F (Table 6 in final Appendix E) and will deem that a reasonable estimate for employers to use when performing incident-energy calculations for single-phase open-air exposures on voltages of 46 kilovolts and less. Employers may use other distances if those distances reasonably resemble the actual exposures faced by employees.

TVA maintained that the 380-millimeter (15-inch) distance assumption for these exposures was too small, commenting:

> OSHA states that an employee's chest will be about 380 millimeters (15 in.) from an energized conductor during rubber glove work on that conductor. A review of anthropometric estimates ("Anthropometry, Ergonomics, and the Design of Work" by S. Pheasant) for British adults (19 to 65 years old) shows that the elbow to finger tip length for the 5th percentile is 440 mm (17.3 inches) for men and 400 mm (15.75 inches) for women. After adding a distance of 51 mm (2 inches) for the arms to move toward the front of the body and into a working position, the distance from the chest to the potential arc point will be 451 mm (17.76 inches) for women and 491 mm (19.33 inches) for men. Based [on] this data, the default distance from the worker to the arc point should be 451 mm (17.76 inches) or about 18 inches. The 15-inch distance proposed by [OSHA] will increase the calculated arc flash incident energy, which means that employees will have to wear heavier protection within the area of the arc flash boundary. This heavier protection is not warranted based on anthropometric data. IEEE 1584 states that a typical distance is 455 mm (17.91 inches) to the arc for cable work and low voltage panelboards and motor control centers. It is recommended that the final rule adopt 457 mm (18 inches) as the default distance to the arcing point. [Ex. 0213]

OSHA does not dispute the anthropometric data described by TVA. However, the Agency does not agree with TVA's application of this data to rubber glove work. An employee working in a comfortable position on a conductor will have his or her upper and lower arms at an angle of about 60 degrees (269-Ex. 8–5). This position forms an equilateral triangle with the sides produced by the upper arm, the lower arm, and the distance between the employee's chest and the conductor. Therefore, the distance from the energized part to the worker's chest is the same as the distance between the energized part and the worker's elbow. Although the 95th percentile distance between the elbow and the fingertip may be 440 millimeters (17.3 inches), the conductor will be closer than that distance because it will originate at the crotch between the thumb and the palm rather than at the fingertip (*id.*). Subtracting 60 millimeters (2.4 inches) from the length of the lower arm, which is a conservative approximation of the distance between the middle fingertip and the crotch between the thumb and the palm, yields a distance of 380 millimeters (15 inches). This is the approximate distance between an employee using rubber gloves on an energized conductor and the live part, which also is the same distance as the estimated distance TVA was challenging.[331] OSHA does not dispute the IEEE Std 1584 distance mentioned by TVA; however, the IEEE distances are for cables and enclosed equipment, not for open conductors in air (which involve the use of rubber insulating gloves). The Agency concludes that the distance from the arc to the employee should be different for these exposures, as explained later. Consequently, OSHA concludes that 380 millimeters (15 inches) is a reasonable distance to assume between the employee and the arc for work by employees using rubber gloves involving exposures to single-phase arcs of up to 46 kilovolts in open air.

At voltages higher than 46 kilovolts, employees must use live-line tools or the live-line barehand technique to handle energized parts.[332] For this work, OSHA considers it reasonable to calculate incident-energy exposures for single-phase open-air arcs using a distance from the employee to the arc that is equal to the applicable minimum approach distance minus twice the arc length. In this case, the employee would be at the minimum approach distance from the energized part,[333] where OSHA assumes the arc occurs, and subtracting twice the arc length from that distance accounts for movement of the arc[334] and for small errors in judging and maintaining the minimum approach distance. There is no evidence on the record that this distance is unreasonable, and the Agency received no adverse comments on that assumption. Therefore, OSHA concludes that, for exposures involving single-phase arcs in open air when employees perform work using live-line tools, a reasonable estimate of the distance from the arc to the employee is the minimum approach distance minus twice the arc length.

Table 9 in proposed Appendix F only covered work on systems operating at more than 46 kilovolts. The Agency recognizes that some employers require their employees to use live-line tools on voltages of 46.0 kilovolts and less. (See, for example, Exs. 0125, 0127, 0159.) Therefore, the Agency is extending Table 7 in final Appendix E to cover these lower voltages as well. Table 7 applies whenever employees use live-line tools, irrespective of voltage, because OSHA based the table on the work method, not on the voltage. OSHA also revised the titles of Table 6 and Table 7 in final Appendix E to indicate that they are applicable to work using

[329] Work is not performed on energized parts in the 46.1- to 72.5-kilovolt range using rubber insulating gloves. The maximum voltage rating for rubber insulating gloves is 36 kilovolts. (See Table E–4 to final § 1926.97.) The phase-to-ground voltage on a 72.5-kilovolt circuit is 41.8 kilovolts, which is above the maximum use voltage for rubber gloves. Minimum approach distances are set for the 46.1- to 72.5-kilovolt range based on the rubber insulating glove work technique because rubber insulating glove work is performed close to energized parts in this voltage range. For the purposes of estimating incident-energy levels, the Agency believes that the most likely electric arc will generally involve live parts the employee will be handling, which will be energized at 46 kilovolts or less.

[330] Rubber insulating gloves with leather protectors and rubber insulating sleeves normally cover the employee's arms. This equipment provides protection against incident heat energy (Exs. 0373, 0466; Tr. 434).

[331] OSHA's approach is identical to the approach taken by the 2007 NESC in Table 410–1 (Ex. 0533). (The 2012 NESC retains this approach in Table 410–2.)

[332] Although the rest of this discussion relates to work performed using live-line tools, an employer can use the same technique to reasonably estimate the distance from the employee to the electric arc when the employee is performing live-line barehand work. An employee performing live-line barehand work is at the potential of the conductor and is maintaining the applicable minimum approach distance from ground. From the worker's perspective, the dangerous potential is ground, not the conductor to which he or she is bonded. In that case, the employer can reasonably assume that the arc, if one occurs, will be close to objects at ground potential as, for example, if an energized conductor drops onto a grounded tower leg, or at the potential of other phase conductors as, for example, if a phase conductor drops on another phase conductor below.

[333] The design of the live-line tool keeps the employee at a distance from the energized part equal to, or greater than, the applicable minimum approach distance.

[334] When the arc initiates, the worker is likely to react by pulling the live-line tool away from the energized part and toward himself or herself. This action would pull the arc toward the worker. If the worker reacts in the opposite direction, then he or she would get closer to the arc.

rubber insulating gloves and live-line tools, respectively, rather than work on systems based on voltage as proposed.

One mechanism for reducing estimated incident energy is to move the employee farther away from the electric arc. One way to accomplish this objective is to use live-line tool work methods with a larger minimum approach distance than the minimum distance required by paragraph (c)(1) of final § 1926.960. OSHA encourages employers to use such methods to reduce incident-energy levels. If an employer requires an employee to maintain a minimum approach distance greater than the minimum distance required by paragraph (c)(1), OSHA would deem it reasonable for the employer to use an estimate of the distance from the employee to the arc that reflects the employer-imposed minimum approach distance rather than the minimum approach distance required by the standard.

Work that exposes employees to three-phase arcs in open air, or single-phase or three-phase arcs in enclosures, typically involves the employee working at a greater distance from energized parts than is the case when an employee is working on a single phase conductor of an overhead line. For example, employees typically perform work on energized equipment using insulating tools or test equipment on the energized parts or by operating the equipment or removing covers. In the first two cases, that is, using insulated tools or test equipment on energized parts, the employee will be working with arms extended. In the latter two cases, that is, operating the equipment or removing covers, employees would be working with their hands near the outside of equipment. OSHA believes that, in all four cases, it is reasonable to assume that the employee is working at a greater distance from the energized parts than an employee working with rubber insulating gloves on energized overhead line conductors. IEEE Std 1584a–2004 uses distances based, at least in part, on the dimensions of the equipment enclosure (Ex. 0425). Because IEEE designed that standard to address a wide range of equipment, OSHA believes that the IEEE approach is broadly applicable to work on energized equipment. The IEEE approach is explained in Section 4.8 of that standard as follows:

> Arc-flash protection is always based on the incident energy level on the person's face and body at the working distance, not the incident energy on the hands or arms. The degree of injury in a burn depends on the percentage of a person's skin that is burned. The head and body are a large percentage of total skin surface area and injury to these areas is much more life threatening than burns on the extremities. Typical working distances are shown in [the following table:]

Classes of equipment	Typical working distance[a] (mm) [inches]
15 kV switchgear	910 [36]
5 kV switchgear	910 [36]
Low-voltage switchgear	610 [24]
Low-voltage MCCs[335] and panelboards	455 [18]
Cable	455 [18]
* * * * * * *	

[a] Typical working distance is the sum of the distance between the worker standing in front of the equipment, and from the front of the equipment to the potential arc source inside the equipment. [*id.*[336]]

IEEE Std 1584a–2004—*IEEE Guide for Performing Arc-Flash Hazard Calculations—Amendment 1*—Reprinted with permission from IEEE—Copyright 2004, by IEEE. (Table revised from original).

There is no evidence on the record that the distances in IEEE Std 1584–2004 for three-phase arcs in open air or single-phase or three-phase arcs in enclosures are unreasonable. Therefore, OSHA concludes that the distances in IEEE Std 1584–2004 described earlier are reasonable estimates for the distance from the employee to the electric arc for three-phase arcs in open air, and single-phase and three-phase arcs in enclosures, for voltages up to 15 kilovolts. Above that voltage, employers must consider equipment enclosure size and the working distance to the employee in selecting a distance from the employee to the arc. The Agency will consider a distance reasonable when the employer bases it on equipment size and working distance.

Summary and discussion of general issues related to incident-energy calculation methods. Table 12, Table 13, and Table 14 in this preamble summarize OSHA's findings related to methods employers can use to estimate incident heat energy as required by final paragraph (g)(2). OSHA included these tables in Appendix E to Subpart V in the final rule to enable employers to readily select incident-energy calculation methods and input parameters that OSHA will consider reasonable and acceptable for compliance with paragraph (g)(2) of final § 1926.960.

TABLE 12—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–2004 Annex D (Lee equation)[3]	Y–C	Y	N	Y–C	Y–C	N	N[4]	N[4]	N[4]
Doughty, Neal, and Floyd	Y–C	Y	Y	N	N	N	N	N	N
IEEE Std 1584–2004[5]	Y	Y	Y	Y	Y	Y	N	N	N
ARCPRO	Y	N	N	Y	N	N	Y	Y[6]	Y[6]

Key:
1Φ: Single-phase arc in open air

[335] Motor control center.

[336] IEEE Std 1584b-2011 makes editorial changes to the quoted paragraph and adds a column with English units to the table. The metric distances in the table remain unchanged.

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 OSHA will consider these methods reasonable for enforcement purposes when employers use the methods in accordance with this table, employers should be aware that the listed methods do not necessarily result in estimates that will provide full protection from internal faults in transformers and similar equipment or from arcs in underground manholes or vaults.
[2] At these voltages, the arc is presumed to be 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] The entries for NFPA 70E–2004 Annex D (Lee equation) apply equally to NFPA 70E–2012, and the comparable table in Appendix E refers to NFPA 70E–2012 Annex D (Lee equation).
[4] Although OSHA will consider this method acceptable for purposes of assessing whether incident energy exceeds 2.0 cal/cm^2, the results at voltages of more than 15 kilovolts are extremely conservative and unrealistic.
[5] The entries for IEEE Std 1584–2004 apply equally to IEEE 1584–2011, and the comparable table in Appendix E refers to IEEE Std 1584 with this latest amendment.
[6] OSHA will deem the results of this method reasonable when the employer adjusts them using the conversion factors for three-phase arcs in open air or in an enclosure, as indicated in the program's instructions.

TABLE 13—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) [3]	Phase conductor spacing.
Single conductor in air, more than 15 kV	Voltage in kV times 2.54 (0.1), but no less than 51 mm (2 inches) [3].	Phase conductor spacing.

[1] Source: IEEE Std 1584a–2004.
[2] "NA" = not applicable.
[3] Table 6 of Appendix E of final Subpart V uses a more conservative arc gap that equals the electrical component of the minimum approach distance rather than a value corresponding to the dielectric strength of air for the system voltage, which forms the basis for the values in this table.

TABLE 14—SELECTING A REASONABLE DISTANCE FROM THE EMPLOYEE TO THE 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.	$MAD - (2 \times kV \times 2.54)$	NA
	$(MAD - (2 \times kV / 10))$†	

*"NA" = not applicable.
† The terms in this equation are:
MAD = The applicable minimum approach distance, and
kV = The system voltage in kilovolts.

With the guidance provided here and in Appendix E to final subpart V, OSHA believes that employers will be able to reasonably estimate incident-energy levels as required by final paragraph (g)(2). The Agency expects that, upon inspection, it will be able to detect any manipulation of input parameters designed to undermine the purpose and requirements of this final rule.

In enforcing paragraph (g)(2) of the final rule, the Agency will accept as reasonable any estimates made following the guidance in the preamble and in Appendix E. Employers may depart from this guidance as long as the methods and variables used to calculate incident heat energy relate reasonably to the electric-arc exposures actually faced by employees. Duke Energy pointed out that "standard writing committees . . . are continuing to address the electric-arc hazards, specifically NFPA 70E, IEEE Std 1584–2002, and technical papers written by the IEEE/ESMOL[337] committee" (Ex. 0201). These efforts may result in additional sources of information for employers to use in estimating incident heat energy for purposes of final paragraph (g)(2).

Several rulemaking participants noted that IEEE and NFPA are undertaking a joint research effort to address issues related to methods of calculating incident heat energy from electric arcs. (See, for example, Exs. 0177, 0201, 0227; Tr. 1095, 1128–1129.) These rulemaking participants recommended that OSHA delay the rulemaking pending the results of this research. For example, Ms. Kathy Wilmer, testifying on behalf of EEI, stated:

[337] Electrical Safety and Maintenance of Lines.

In 2005, IEEE and NFPA sponsored a joint task force whose charge was to develop a research and test plan intended to address technical issues, including those raised by the calculation methods. It will be several years, however, before the results of the IEEE/NFPA Research and Test Plan Committee are available to employers. [Tr. 1095]

EEI recommended that "OSHA wait for NFPA and IEEE to answer some of [the] questions" related to the calculation methods (Tr. 1129).

As noted by Ms. Wilmer, the results of any research conducted as a result of the IEEE–NFPA joint effort may be years away. Today, the final results of this research are not available. OSHA concludes that there is sufficient information in the rulemaking record to determine that existing calculation methods can reasonably estimate incident heat energy from electric arcs. Therefore, the Agency does not believe that it is necessary to wait for IEEE and NFPA to complete the research. In the future, this research may result in additional sources of information for employers estimating incident heat energy for the purposes of final paragraph (g)(2).

Note 2 to paragraph (g)(2), which is being adopted without substantive change from the proposal, explains that paragraph (g)(2) does not require the employer to estimate the heat-energy exposure for every job task performed by each employee. The note indicates that the employer may 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.

Proposed Appendix F explained that the employer could use the maximum fault current and clearing time to cover several system areas at once.

NIOSH expressed concern that, following this guidance, an employer could estimate incident energy based on the maximum available fault current, even though a higher incident-energy level is possible with a lower fault current (Ex. 0130). NIOSH explained:

[Proposed Note 2 to paragraph (g)(2) and proposed Appendix F] suggest that the point in a power system that has the highest available fault current will also have the maximum heat energy hazard in the event of an arcing-fault. [T]he heat energy released during an arcing-fault is a function of both current and duration (clearing time). The maximum heat energy hazard may be at a point in the system where available fault current is less than the system maximum and may consequently have a longer clearing time. This longer clearing time is due to the inverse-time characteristic of many circuit protection components such as fuses and relays (the higher the fault current, the more quickly the circuit protection components will clear the fault). [*Id.*]

NIOSH recommended "providing a more detailed explanation of the interdependence of current and clearing time with respect to arcing-fault hazards," and indicated that "NFPA 70E–2004 provides an example of such an explanation" (*id.*).

OSHA recognizes that fault current lower than the maximum available fault current can produce a higher incident energy. The maximum fault current, also known as the bolted-fault current, occurs when the fault has no impedance,[338] as if the two conductors were bolted together. The current in an electric arc is never as high as the maximum available fault current because the arc itself has some impedance, and this lowers the fault current. All of the incident-energy calculation methods, except ARCPRO, account for this reduction (Exs. 0134, 0425, 0430, 0469).

As NIOSH notes, when the current is less than the maximum available fault current, the protective devices for the circuit may take longer to clear the fault, resulting in longer clearing times. IEEE Std 1584a-2004 accounts for this difference in clearing times and for variations in arc current with arc voltage in the formulas it uses to calculate incident energy (Ex. 0425). The other methods use the clearing time corresponding to the fault current used to calculate the incident energy.

However, the fault current and the clearing times used to calculate incident energy in these calculations are only approximations of the values that might occur in an actual fault. Like the distance from the employee to the arc and, in some cases, the arc length, the fault current and clearing time in an actual fault likely will be different from the fault current and clearing time used to calculate incident energy. The final rule requires that the employer's estimate of incident energy be reasonable, not that it be a precise estimate of the maximum possible incident energy. Lower fault current may produce a higher incident energy, but so would exposures with the employee closer to the arc. Other variations, such as short clearing times (which can occur if the arc self-extinguishes) or longer distances between the employee and the arc, could lead to lower incident energy. Considering the evidence in the record as a whole, the Agency believes that using maximum fault current in estimating incident energy will produce reasonable estimates of the exposures faced by employees.

Mr. John Vocke with Pacific Gas and Electric Company stated that his company conducted testing to verify the values in Table 8 and Table 9 in proposed Appendix F (Ex. 0185). He maintained that the incident-energy values provided in those tables may be inaccurate.

As noted earlier, the Agency concluded that the ARCPRO method, on which OSHA based the incident-energy values in proposed Table 8 and Table 9, reasonably estimates incident energy from single-phase arcs in open air on systems of more than 600 volts. Mr. Vocke did not provide the parameters used in, or the results of, Pacific Gas and Electric Company's testing. For example, it is not clear from Mr. Vocke's comment whether the testing was with single-phase arcs in open air. If not, then the Agency would expect their results to differ from the values in proposed Table 8 and Table 9.

As described earlier, OSHA based Table 8 and Table 9 in proposed Appendix F on calculations using ARCPRO and designed those tables to cover a wide range of exposures faced by employees performing overhead line work. TVA noted that these tables had little application and expressed concern that employers would misuse the tables, commenting:

We believe the use of tables, e.g., * * * proposed Tables 8 & 9, have limited application for estimating heat energy for electrical circuits common to the electric utility industry. The footnotes to these tables instruct users to use other methods if the circuit assumptions in the tables are not applicable to the circuit being analyzed. Our concern is that many companies will not understand the limitations of these tables or choose to ignore the instruction to use other methods. Either of these actions could result in under estimating the arc flash hazard.

* * * * *

[W]e do not agree with the "table" method approach. We believe that for many exposures in generating and transmission facilities OSHA's proposed Tables 8 and 9 will not be useful to employers for selecting arc flash protection. The tables are misleading because in reality there are too many circuits with parameters that do not meet the table use criteria. OSHA states in [proposed Appendix F] that employers will need to use other methods in situations not addressed by Table 8 or Table 9. We believe that an accepted method should be used to calculate arc flash incident energies and recommend that the final rule not include tables like proposed Table 8 and Table 9 for selecting arc flash protection. [Ex. 0213]

[338] Impedance is the effective resistance of an electric circuit to alternating current. It includes the combined effects of ohmic resistance and reactance.

OSHA believes that Table 8 and Table 9 from proposed Appendix F (Table 6 and Table 7 in final Appendix E, which OSHA revised as described elsewhere in this section of the preamble) serve as relatively simple ways for employers to estimate incident energy. The SBREFA Panel Report specifically recommended that OSHA consider including such tables in the standard (Ex. 0019). The National Electrical Safety Code committee adopted provisions on protection from electric arcs that included tables similar to the ones in the proposal (Ex. 0480). Mr. James Tomaseski of IBEW supported the proposed tables and stated that the values in those tables represent "common exposures out on distribution lines" (Tr. 939—940). Mr. Brian Erga with ESCI also supported proposed Table 8 and Table 9, testifying:

> ESCI fully supports the table 8 and table 9 in the appendix of this proposal as a way of providing a method of choosing some FR clothing for workers or small companies.
>
> It will allow a company to figure out, take their fault current, their clearing time, go into a table, and find . . . some clothing that might be appropriate, buy that for them, and feel . . . assured that they were doing what they could do and . . . what OSHA would require. [Tr. 1246–1247]

The Agency concludes that Table 8 and Table 9 in proposed Appendix F will assist employers in complying with the requirement in final paragraph (g)(2) to estimate incident heat energy and that the tables reasonably represent exposures in electric distribution systems, as noted by Mr. Tomaseski, if not transmission systems.[339] (See, also, Mr. Erga's testimony at Tr. 1247: "I passed table 8 and table 9 around to my customers. All of them feel it looks very good and looks very straightforward for them to follow. And they feel pretty comfortable that they would be willing to get into an FR program using [those] table[s] . . . .") Consequently, OSHA is including the tables in final Appendix E, with revisions as described elsewhere in this section of the preamble. OSHA agrees with TVA that it is important for employers to heed the notes to these tables, which limit their application to rubber insulating glove work (Table 6) and live-line tool work (Table 7) involving exposure to single-phase arcs in open air. OSHA further agrees that these tables are of little, if any, use in electric power generating plants, where most of the exposures come from three-phase arcs. Nevertheless, the Agency believes that many employers, especially small ones, will find these tables useful.

Mr. Tom Chappell of Southern Company suggested that the final rule not require incident-energy estimates for voltages of 600 volts and less, arguing that these systems do not pose the same risk as higher voltage systems:

> This proposed language would require that the employer make estimates of the maximum available heat energy to which employees are exposed to at 600 volts and below as well as those above 600 volts. We do not believe this to be reasonable. Even OSHA recognizes that the risks of exposures at 600 volts and below do not carry the same risk as those above 600 volts since the proposed regulations do not require flame resistant clothing at voltages 600 volts and below. Additionally, Note 2 suggests making broad estimates that cover multiple system areas, and further gives an example of how that may be done for distribution circuits. Both of these suggest that the OSHA's intent was not to cover systems operating at 600 volts or less where such broad estimates are meaningless and not possible. We recommend that estimates of heat energy not be required for systems operating at 600 volts and below and that engineering controls and work practices be used for these systems so that contact is avoided. This recommendation would be consistent with NESC proposed language. [Ex. 0212]

Mr. Chappell misunderstood the rationale behind OSHA's final rule. First, Note 2 to proposed paragraph (g)(2), which OSHA is adopting without substantive change, contained an example, clearly identified as such, of how to estimate incident heat energy over a wide area. There are other possible circuits that might be suitable for wide estimates. In addition, the note only addresses circuits that are far-ranging, such as transmission and distribution circuits. Circuits that operate at 600 volts and less are found normally as services or as feeder or branch circuits inside electric power generation plants. (See, for example, 269-Exs. 8–5, 8–17, 8–20, 8–21, 8–22.) These circuits do not normally extend for miles; each of them usually serves a single facility. Second, OSHA does not agree that 600-volt systems produce lower amounts of incident energy or pose a lower risk of burn injury to employees than higher voltage systems. The rationale behind the requirement in final § 1926.960(g)(4)(i) that employees exposed to contact with circuit parts operating at more than 600 volts wear flame-resistant clothing relates to the reduced likelihood that contact with a circuit part energized at lower voltages would produce an electric arc through, and ignite, the clothing. As noted under the summary and explanation for final paragraph (g)(4)(i), many commenters noted that systems operating at 600 volts and less are capable of producing extremely high levels of incident energy, sometimes even higher than systems operating at higher voltages. For example, Mr. Paul Hamer stated, "Many systems and equipment operating at 600 volts and below have severe arc-flash hazards . . ." (Ex. 0166). In addition, TVA noted:

> The magnitude of the heat energy in 480 V arc flash accidents is greater [than at voltages higher than 600 volts] because of the following: 1. The single phase fault typically propagates to three phase fault. 2. The clearing times in generating plants are typically longer. 3. The arc flash energy is typically forced into one direction (arc in a box). [Ex. 0213]

Therefore, while there may not be an ignition hazard from contact at the lower voltages, burn hazards at these voltages may still be serious and require arc-rated protective equipment.

For these reasons, OSHA is not adopting Mr. Chappell's recommendation. The Agency believes that it is just as important to estimate incident-energy levels for systems operating at 600 volts and less as it is for systems of higher voltages. Without an estimate of incident energy, an employer would not be able to select appropriate arc-rated protective equipment for employees exposed to these voltages in accordance with final § 1926.960(g)(5).

Some rulemaking participants maintained that incident-heat-energy exposures change over time. (See, for example, Exs. 0126, 0163; Tr. 404–405.) For instance, Ms. Susan O'Connor with Siemens Power Generation commented that "if new equipment is added or the available fault current to the plant from the utility changes, the entire calculations change. The arc faults become a moving target" (Ex. 0163). Noting that fault current can change hourly, Mr. James Shill with ElectriCities of North Carolina testified:

> [I]n one of my first assignments in the power company I was in charge of coordinating the equipment, and fault currents change hourly. [I]t depends on where your source of energy comes from. [Tr. 404]

The final rule does not require employers to estimate incident-energy levels on a moment-by-moment basis. As indicated by Note 2 to paragraph (g)(2), the final rule permits employers to make broad estimates of incident-energy exposure, provided those

[339] Although there is nothing in the record that states explicitly that Table 9 represents actual exposures for employees working on transmission systems, the existence of similar tables in the 2007 NESC (Ex. 0533) and the 2012 NESC strongly suggests that Table 9 does reasonably represent transmission exposures. (Table 8 of proposed Appendix F covers only distribution voltages.)

estimates represent the reasonably expected maximum exposures. There would be no need to perform additional calculations when changes to the system would lower incident energy. In addition, as long as the protective clothing and other protective equipment selected by the employer will protect against the incident energy, including any increase caused by changes to the system, the final rule does not require the employer to reconduct the incident-energy estimates required by paragraph (g)(2).

The Agency believes that employers will select arc-rated protective equipment, not on the basis of estimates for individual circuits, but on the basis of what levels will provide protection for broad areas of the employers' systems. For instance, an employer could select a base clothing outfit rated at 8 cal/cm.[2] This clothing would be acceptable as long as the estimated energy levels are less than that value. Accordingly, OSHA believes that an employer can take measures to minimize the number of times it must perform additional calculations. For example, an employer using Table 6 or Table 7 in final Appendix E, can select an incident-energy estimate for a maximum number of cycles at a given level of fault current on a particular circuit. As long as any change to the circuit does not increase the fault current or clearing time beyond the fault current and clearing time used in selecting a value from the table, the employer would not have to make additional estimates. The employer then would know that as long as relay settings (which affect clearing time) and transformer kilovolt-ampere ratings (which affect maximum fault current) stay below the values on which the employer bases the selection of incident-energy level, then employees would remain safe, and the employer would remain in compliance. Thus, the employer could avoid having to reestimate incident-energy levels simply by limiting the types of changes that could be made to a circuit or by selecting protective clothing and other protective equipment that accommodates any changes that will be made. As Mr. Donald Hartley of IBEW testified: "[If] you don't find that [the fault current and clearing times] are substantially different [then] you may not have to change what it is you were doing" (Tr. 1031–1032). On the other hand, it is possible that employers that do not adequately plan changes to their systems will need to reestimate incident heat energy for some of their circuits.

OSHA does not expect employers to account for unanticipated changes to their systems in estimating incident-energy levels. As Mr. Shill noted, it is possible that an unanticipated system change could increase incident energy. For example, an unidentified faulty relay could substantially increase the clearing time and, thus, an employee's potential incident-energy exposure. However, final paragraph (g)(2) does not require employers to anticipate such events. The estimates required by this paragraph are for normal operating conditions.

For these reasons, OSHA concludes that concerns that employers would need to constantly update their incident-energy estimates are largely baseless. To the extent that employers must update these estimates, the Agency's regulatory analysis fully accounts for periodic updates. (See Section VI, Final Economic Analysis and Regulatory Flexibility Analysis, later in the preamble.)

Some commenters maintained that employers would need to hire consultants to perform the incident-energy calculations required by final paragraph (g)(2). (See, for example, Exs. 0163, 0178; Tr. 375–376, 563.) Mr. James Shill of ElectriCities of North Carolina testified: "Even if professional engineers know the method to use in calculating maximum available heat energy, small electric utilities often do not have such qualified personnel on staff. Instead, small utility businesses will be faced with hiring outside consultants to perform this work for each job at each workplace, and for each employee" (Tr. 375–376).

OSHA agrees with these commenters that small employers may need to hire consultants to perform or assist in the preparation of incident-energy calculations. Even some larger utilities hire consultants to help perform incident-energy calculations (Tr. 1197). The Agency understands that estimating incident heat energy demands some electrical engineering expertise. OSHA believes that most employers that work on electric power generation, transmission, and distribution systems have such engineering expertise available. As noted by some witnesses, these estimates require much of the same knowledge and skill as other assessments needed to operate, maintain, and work on electric power generation, transmission, and distribution systems (Tr. 1030–1032). In any event, OSHA's estimate of the costs associated with complying with paragraph (g)(2) in the final rule accounts for the possibility that, in some instances, consultants will perform the required estimates. (See Section VI, Final Economic Analysis and Regulatory Flexibility Analysis, later in this preamble.)

Some rulemaking participants suggested that contractors would have difficulty estimating incident energy or would not be able to perform the estimates at all. (See, for example, Exs. 0162, 0169, 0234, 0501; Tr. 1326–1327, 1335–1336.) For instance, Quanta Services noted that utility operators frequently do not know the maximum fault current on their systems, making it "difficult [for contractors] to determine the maximum fault current" (Ex. 0234). The Davis H. Elliot Construction Company suggested that utilities might provide worst-case estimates to their contractors because of potential liability concerns (Exs. 0156, 0206, 0231).

OSHA understands that contractors may face challenges in estimating incident heat energy as required by paragraph (g)(2) in the final rule. The requirements in final § 1926.950(c)(1), which specifies that host employers provide information about their systems to contract employers, should ensure that contractors have the information they need to estimate incident energy. Paragraph (c)(1)(iii) of final § 1926.950 specifically requires host employers to provide information to enable contract employers to perform the assessments required by the final rule. This would include information contractors need to estimate incident heat energy as required in final § 1926.960(g)(2).[340] In any case in which the host employer does not provide the contractor with necessary information and, therefore, violates this final rule, contractors can use other (albeit less certain) means of estimating the system parameters needed to perform incident-energy calculations. Contractors can estimate fault currents through the ratings of the transformers supplying the circuit[341] and clearing times from the type of overcurrent devices protecting the circuit[342] (Ex. 0425; 269-Ex. 8–15). The Agency assumes that, when utilities are

[340] In the economic analysis, OSHA assumes that costs related to estimating incident energy will be borne only by host employers. The Agency anticipates that, for economic reasons, host employers will provide the results of their estimates to contract employers even though the final rule does not require them to do so. See Section VI, Final Economic Analysis and Regulatory Flexibility Analysis, later in the preamble.

[341] For example, a contractor can estimate the fault current on the secondary side of a transformer on a radial system by calculating the fault current at the transformer, which is equal to the transformer rating divided by the product of the per-unit impedance and the voltage (Ex. 0134).

[342] IEEE Std 1584a–2004 gives the clearing times for a wide range of circuit protective devices (Ex. 0425). Contractors also can try to obtain clearing times from a number of other sources, including the manufacturer.

not providing this information, contractors already are using these methods when determining the size of grounds necessary under existing § 1910.269(n)(4)(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.") There is no evidence in the record that utilities are currently providing unduly conservative estimates of fault current or clearing times to contractors for the purposes of existing § 1910.269(n)(4)(i), and it seems unlikely that they would provide different estimates after this final rule becomes effective. Consequently, the Agency concludes that the concerns specific to contractors are baseless.

Several commenters suggested that proposed paragraph (g)(2) was too vague. (See, for example, Exs. 0126, 0152, 0227; Tr. 1095–1097.) For instance, Ms. Jean Thrasher with Community Electric Cooperative commented: "With undefined terms in the equation and no firm guidelines from OSHA the employer has the potential to be cited even though they performed a good faith appraisal but the inspector disagreed with the values chosen" (Ex. 0152).

OSHA made it clear in this preamble and in Appendix E to final Subpart V that the employer is free to choose any method for estimating incident energy that results in a reasonable estimate of incident heat energy to which the employee would be exposed. Appendix E provides guidance on how to estimate incident heat energy and information on approaches that OSHA will recognize as reasonable for performing these estimates. In the final rule, OSHA revised Note 1 to paragraph (g)(2) to further clarify what constitutes compliance with that paragraph. The revised note provides that: (1) OSHA will deem employers that follow the guidance in Appendix E to be in compliance with paragraph (g)(2), and (2) employers can choose another method of estimating incident heat energy if the chosen method reasonably predicts the incident energy to which the employee would be exposed. (Note 1 in the proposal simply referred to the appendix for guidance.) Employers can rely on the guidance in this preamble and final Appendix E to select methods and input parameters accepted by OSHA for compliance with final paragraph (g)(2). Accordingly, the Agency concludes that paragraph (g)(2) in the final rule is not unenforceably vague.

Proposed paragraph (g)(2) would have required employers to make "a reasonable estimate of the maximum available heat energy to which the employee would be exposed." OSHA concludes that this language might not accurately convey the purpose of the proposed rule and, therefore, could confuse the regulated community. For example, as should be clear from the foregoing explanation of what OSHA will consider a "reasonable estimate," the Agency believes that it is reasonable to estimate incident-energy exposures based on the location where an employee is reasonably expected to be working when an arc occurs. However, as explained earlier, the maximum heat energy will occur within the arc plasma, and the Agency concludes that it is not necessary to estimate heat energy assuming that the employee is close enough to the arc to be within the plasma field. In addition, as explained previously, the choice of methods and other input parameters also can affect the calculated incident energy. To clarify that the Agency is expecting a reasonable estimate, and not an estimate of the maximum heat energy, OSHA replaced the phrase "a reasonable estimate of the maximum available heat energy" in paragraph (g)(2) in the proposed rule with "a reasonable estimate of the incident heat energy" in the corresponding provision in the final rule. The Agency believes that the final rule more accurately reflects the purpose of this provision and will clarify some of the confusion related to the requirement to estimate incident-energy levels.

NIOSH stated that arc warning labels would be valuable for new or upgraded installations (Ex. 0130). NIOSH explained its position as follows:

> Arc warning labels that explain the voltage, available fault current, Arc Hazard Category, the ATPV of the required protective clothing, and the approach distances would be a valuable addition to all new or upgraded installations. Such information, as calculated by the systems' designers, would then be readily available to the workers who need to maintain such systems. Many commercial power systems analysis packages can automatically generate these labels as part of the systems design and analysis procedure. Having labels on new equipment would eliminate the need for the employer to estimate arc hazards by providing calculated engineering data. [*id.*]

OSHA decided against requiring arc-hazard warning labels such as those recommended by NIOSH. OSHA believes that the employer can effectively provide information on arc hazards and the required protective measures in other ways. Employers must train their employees in the recognition of electrical hazards, including hazards from electric arcs, and the proper use of PPE, including FR and arc-rated clothing, as required by final § 1926.950(b)(2)(v) and (b)(2)(iv), respectively. The employer can use several methods other than labels to ensure that employees wear appropriately rated protective equipment, including requiring a minimum level of protection that will cover most exposures and including the arc rating on work orders. OSHA believes that these other measures are likely to be more effective than warning labels since they inform the employee of the appropriate rating before the employee arrives at the jobsite. If the employer relies on labels, employees may arrive at the jobsite without properly rated protective equipment. In addition, OSHA does not believe that providing labels on transmission and distribution installations is feasible or effective. It is not possible to label the entire length of a transmission or distribution line, and installing labels at switching points would not prove effective or useful to employees whose work is remote from those switching points. Therefore, OSHA is not adopting the requirement for arc-hazard warning labels recommended by NIOSH.

Prohibited clothing. Paragraph (g)(3), which is being adopted with only minor changes from the proposal, requires the employer to ensure that employees exposed to hazards from flames or electric arcs do not wear clothing that could either melt onto their skin or ignite and continue to burn when exposed to flames or the heat energy estimated under final paragraph (g)(2). This rule is equivalent to existing § 1910.269(l)(6)(iii), although OSHA revised the language to explicitly prohibit clothing that could melt onto an employee's skin or ignite and continue to burn.[343] Final paragraph (g)(3) ensures that employees exposed to electric arcs do not wear clothing presenting the most severe burn hazards.

A note following this provision lists fabrics, including acetate, nylon, polyester, and rayon, that the final rule specifically prohibits unless the

[343] The existing rule prohibits clothing that could increase the extent of injuries to an employee. The Agency interprets this rule as prohibiting clothing that could melt or that could ignite and continue to burn in the presence of an electric arc faced by an employee. (See, for example, Memorandum to the Field dated August 10, 1995, from James W. Stanley, "Guidelines for the Enforcement of the Apparel Standard, 29 CFR 1910.269(l)(6), of the Electric Power Generation, Transmission, and Distribution Standard." This memorandum is available at *http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=21878.*)

employer demonstrates that the clothing is treated or worn in such a manner as to eliminate the hazard. In the proposed rule, this note was the same as the note following existing § 1910.269(l)(6)(iii). In the preamble to the proposal, OSHA requested comments on whether it should add any other fabrics posing similar hazards to the note.

Many commenters recommended adding polypropylene to the list of prohibited fabrics. (See, for example, Exs. 0148, 0183, 0233, 0239; Tr. 563–564.) Mr. Mark Zavislan, representing NRECA, testified:

> Polypropylene is a synthetic fabric under heat conditions. It melts. It's terrible. I have not witnessed it in an arc type of exposure, but I was an EMT for several years, and one of the worst injuries I have ever seen, vehicle accident involving a fire, an individual wearing long underwear made out of this material, and it was pretty ugly.
>
> So I think, if you are looking at the heat exposures from an arc, you've got the potential for the same type of damage. [Tr. 564]

OSHA finds that this evidence indicates that polypropylene can melt. Although Mr. Zavislan's testimony did not indicate that this fabric is likely to melt in an arc exposure, it does indicate that, if polypropylene is exposed to sufficient heat, it will melt. In this regard, OSHA believes that the heat generated by a arc flash is at least as severe as the heat generated by a vehicle fire. Consequently, OSHA is adding polypropylene to the list of prohibited fabrics contained in the note following paragraph (g)(3) in the final rule.

Two commenters suggested adding acrylic fibers to the list in the note, although they did not provide any evidence that this fabric melts or ignites and continues to burn when exposed to electric arcs (Exs. 0148, 0213). While OSHA decided against adding acrylic fibers to the list of prohibited fabrics contained in the note, the Agency observes that the note's list of the types of fabric prohibited by final § 1926.960(g)(3) is not exhaustive. Employers must ensure that employees do not wear clothing made from an acrylic fiber if such clothing could melt onto the skin or ignite and continue to burn when exposed to the heat energy estimated under final paragraph (g)(2), regardless of whether the note lists the fabric. One of the two commenters that advocated adding acrylic fibers to the note was ASTM. ASTM has extensive experience with testing materials. The Agency suspects that acrylic fibers will melt onto the skin or easily ignite and continue to burn in the presence of an electric arc, although it did not arrive at this conclusion in this rulemaking.

Two commenters recommended removing rayon from the list of prohibited fabrics contained in the proposed note (Exs. 0166, 0228, 0235). These commenters pointed out that rayon is a cellulose-based synthetic fiber that burns but does not melt.

OSHA included rayon as one of the prohibited fabrics on the basis of evidence in the record for the 1994 § 1910.269 rulemaking (59 FR 4389; 59 FR 33658–33659, 33661). In that rulemaking, the Agency described the evidence and rationale for prohibiting certain fabrics as follows:

> The IBEW introduced a videotape, produced by the Duke Power Company, demonstrating the effects of different types of clothing upon exposure to electric arcs (Ex. 12–12). This tape provides clear evidence of the hazards of wearing clothing made from certain untreated synthetic fabrics, such as polyester, acetate, nylon, and rayon.
>
> * * * * *
>
> Therefore, for exposed employees, . . . final § 1910.269 adopts a requirement that these employees be trained in the hazards related to the clothing that they wear [and prohibits] apparel that could increase the extent of injuries received by a worker who is exposed to an electric arc. OSHA has also included a note . . . to indicate the types of clothing fabrics that the record demonstrates are hazardous to wear by employees exposed to electric arcs.
>
> The requirement is intended to prohibit the types of fabrics shown in the Duke Power Company videotape to be expected to cause more severe injuries than would otherwise be anticipated. These include such untreated materials as polyester and rayon, unless the employee is otherwise protected from the effects of their burning. [59 FR 4389, as corrected at 59 FR 33658]

The Duke video indicated that rayon ignites easily in the presence of electric arcs (269-Ex. 12–12). Existing § 1910.269(l)(6)(iii) and final paragraph (g)(3) prohibit clothing that can ignite and continue to burn, in addition to fabrics that can melt onto the skin in the presence of electric arcs. The evidence in the record indicates that rayon meets this criterion. Therefore, OSHA is not removing rayon from the list of prohibited fabrics.

When flame-resistant clothing is required. Proposed paragraph (g)(4) would have required employees to wear flame-resistant clothing whenever: (1) The employee was subject to contact with energized circuit parts operating at more than 600 volts (proposed paragraph (g)(4)(i)); (2) an electric arc could ignite flammable material in the work area that, in turn, could ignite the clothing of an employee nearby (proposed paragraph (g)(4)(ii)); or (3) molten metal or electric arcs from faulted conductors in the work area could ignite the employee's clothing (proposed paragraph (g)(4)(iii)). A note to proposed paragraph (g)(4)(iii) indicated that this provision would not apply to conductors capable of carrying, without failure, the maximum available fault current for the time the circuit protective devices take to intercept the fault. In such instances, conductors would not melt from the fault current and, therefore, could not ignite the employee's clothing. The conditions listed in proposed paragraph (g)(4) address several burn accidents examined by OSHA involving ignition of an employee's clothing (Exs. 0002, 0003, 0004).[344]

OSHA reworded the introductory text to paragraph (g)(4) in the final rule to clarify what clothing must be flame-resistant and to make it consistent with provisions in final paragraphs (g)(5)(i) through (g)(5)(v) that permit some types of non-flame-resistant clothing in lieu of arc-rated clothing in certain conditions. (See the discussion of the difference between flame-resistant and arc-rated clothing under the summary and explanation for final paragraph (g)(5), later in this section of the preamble.) The language in final paragraph (g)(4) makes it clear that only the outer layer of clothing must be flame-resistant. This requirement recognizes that some companies successfully use 100-percent cotton T-shirts under FR shirts. (See, for example, Tr. 1345–1346.) NFPA 70E–2004 also recognizes the use of non-flame-resistant clothing under flame-resistant clothing as providing adequate protection against electric-arc hazards in certain situations (Ex. 0134). In any event, final paragraph (g)(3) prohibits the use of flammable layers of clothing beneath flame-resistant outer clothing whenever doing so poses a burn hazard.

For reasons explained later, OSHA is adopting in the final rule paragraphs (g)(4)(i) through (g)(4)(iii) (including the note) largely as proposed. The Agency is adding a new paragraph (g)(4)(iv) that requires employees to wear flame-resistant clothing whenever the incident heat energy estimated under paragraph (g)(2) exceeds 2.0 cal/cm^2. See the explanation of this new paragraph later in this section of the preamble.

Several rulemaking participants argued that some employers are providing adequate protection for their employees by requiring them to wear 100-percent cotton (that is, that flame-resistant clothing is unnecessary). (See, for example, Exs. 0187, 0238, 0506; Tr.

[344] See, for example, the four accidents described at *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=596304&id=144187768id=170238109&id=202043758.*

543–544.) For instance, Mr. Jonathan Glazier with NRECA stated:

> Many utilities now allow their employees to wear 100 percent natural fiber clothing. This means cotton and, in colder climates, wool or cotton/wool blends. One hundred percent natural fiber clothing complies with OSHA's current 1910.269, if it is thick enough not to ignite and to continue burning, but this will change if the new proposal becomes final.
>
> Proposed Sections 1910.269(l)(11)(4)(a) and 1926.960(g)(4)(i) would require wearing FR clothing—that's FR clothing, not merely clothing that will not melt or ignite and continue to burn, but FR clothing—when an employee is "subject to contact with energized circuit parts operating at more than 600 volts."
>
> Arguably, this means that 100 percent natural fiber clothing cannot be worn by employees doing rubber glove work on parts energized above 600 volts. This will require many utilities that have been successfully allowing 100 percent natural fiber clothing to move to the more expensive and, let's face it, more [problematic] FR clothing. [Tr. 543–544]

The evidence in the rulemaking record clearly shows that flame-resistant clothing is necessary for the protection of employees when the conditions addressed by final paragraph (g)(4) are present. (See, for example, Exs. 0002, 0003, 0004.[345]) Sixteen of the 100 arc-related burn accidents in Ex. 0004, covering the period from 1991 to 1998, involved the ignition of an employee's clothing. Two additional burn accidents involved hydraulic fluid that ignited when an aerial lift approached too close to an energized line (Ex. 0004 [346]). The burning fluid can ignite flammable clothing. Five of these 18 accidents occurred when an employee contacted or came too close to an energized part; 3 accidents involved conductors or equipment that could not carry fault current; and 3 accidents involved flammable materials ignited by an electric arc. OSHA acknowledges that some, or potentially all, of these injuries could occur even if the employees had been wearing flame-resistant clothing. However, flame-resistant clothing can minimize the extent of the injury.

As noted by Dr. Thomas Neal, much of the energy in a typical electric arc is concentrated over one part of the body, and other parts of the body receive less energy (Tr. 496–497).[347] When an employee's clothing ignites, the employee receives burns from the burning clothing, as well as from any other heat sources in the area, such as an electric arc or fire. In such cases, the ignition of clothing exacerbates the extent of any burn injury that may occur. (See, for example, Tr. 188–189, 215, 228.) For this reason, OSHA concludes that preventing clothing ignition in the scenarios in which it is most likely to occur will significantly enhance employee protection. In only one of the 18 incidents mentioned previously was there an indication that the clothing melted, indicating that the clothing probably consisted of one of the fabrics explicitly prohibited by the note to final paragraph (g)(3). Although it is not clear whether the remaining injured employees were wearing 100-percent cotton clothing, it is likely that they were. The record indicates that use of 100-precent cotton clothing is standard practice for electric utilities that do not require their employees to use flame-resistant clothing. (See, for example, Exs. 0173 ("Much of the workforce across the nation uses 100% cotton for their uniforms"), 0187 ("A large number of electric utilities already are providing or requiring their employees to wear flame-resistant clothing or 100 percent cotton clothing").) Because some 100-percent cotton clothing poses an ignition hazard, which final paragraph (g)(4) would likely prevent, OSHA concludes that use of 100-percent cotton in lieu of FR clothing would not adequately protect employees in the situations addressed by paragraph (g)(4).

Pacific Gas and Electric Company requested an exemption from the FR clothing requirements for live-line barehand work (Ex. 0185). The company argued that the conductive suits used for this work provide primary protection for employees and that the electrocution hazard (not the burn hazard) is the primary concern in this type of work (*id.*).

Employers use the conductive clothing described by Pacific Gas as a form of shielding to minimize potential differences and body current for employees performing live-line barehand work (Ex. 0041). The clothing assists in bonding the worker to the energized part and keeps the worker from experiencing minor electric shocks as he or she moves along a conductor. Where the conductive fibers that make the suit conductive break, hot spots can develop (*id.*). It is important for this clothing to be flame-resistant material, or these hot spots could ignite the clothing. Consensus standards require that conductive clothing used in live-line barehand work be flame-resistant; therefore, conductive clothing manufactured with FR fabric with interwoven conductive fibers is readily available (269-Ex. 60 [348]; Ex. 0041). Accordingly, OSHA has decided against exempting live-line barehand work from final paragraph (g)(4).[349]

EEI argued that proposed paragraph (g)(4) was too vague, commenting:

> [The requirements in this paragraph] call for determinations for which objective criteria are absent. . . . For example, on what basis is an employer to determine that an electric arc could ignite a flammable material that could in turn ignite the clothing of an employee? What kind of calculations does this require, especially considering that it is virtually impossible to predict the movement of an electric arc? Likewise, how is an employer to determine that an employee's clothing could be ignited by molten metal? In sum, the standard calls for speculation, not an objective determination, and therefore does not satisfy due process requirements. [Ex. 0227]

OSHA disagrees with EEI's comment that the requirement for flame-resistant clothing is vague. The Agency believes that employers can determine the presence of each of the conditions listed in final paragraph (g)(4) through a reasonable assessment of what conditions they can expect when an electric arc occurs. This assessment should be part of the hazard assessment required by final paragraph (g)(1). For purposes of final paragraph (g)(4)(i), if the employee is using the rubber glove work method within reaching distance of circuit parts energized at more than 600 volts or if the employee is using the live-line tool work method underneath parts energized at more than 600 volts, OSHA will consider the employee to be "exposed to contact" with those parts. The proposed rule used the phrase "subject to contact," which the Agency has changed in the final rule to the

[345] See the 16 accidents described at *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=144187768id=170611057&id=170191050&id=170203871&id=14241863&id=14277487&id=170193353&id=170061972&id=880658&id=170238109&id=170053128&id=170720957&id=880112&id=202043758&id=14373245&id=596304.*

[346] See the two accidents described at *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=200671253&id=201340395.*

[347] Thomas Neal has a Ph.D. in analytical chemistry. He worked for E. I. du Pont de Nemours and Company for 30 years, primarily in the field of protective clothing. He has worked with ASTM to develop standards for arc testing and has substantial experience with protective garments used for arc-flash protection (Tr. 491–492).

[348] IEC 60895–2002, *Live working—Conductive clothing for use at nominal voltage up to 800 kV a.c. and ± 600 kV d.c.*, is the international standard for conductive clothing. IEEE Std 516–2009 references this standard (Ex. 0532). Since 1987 when IEC first adopted its standard, IEC 895–1987, *Conductive clothing for live working at a nominal voltage up to 800 kV a.c.*, the consensus standard required conductive clothing to be flame-resistant (269-Ex. 60).

[349] Note that estimates of incident energy for live-line barehand work may assume that the arc is most likely to form at objects at potentials different from the worker, such as grounded objects.

phrase "exposed to contact." (See the discussion of that phrase under the summary and explanation of final § 1926.960(b)(3) earlier in this section of the preamble.) That change should clarify the meaning of this paragraph.

For purposes of final paragraph (g)(4)(ii), OSHA will be looking for flammable material, such as insulating hydraulic fluid, in the work area close to where an arc may occur. In such situations, the arc can be expected to ignite the fluid, with the burning fluid then igniting an employee's flammable clothing.

For purposes of final paragraph (g)(4)(iii), if there are conductors, such as pole grounds, that energized parts may contact during the course of work and if these conductors cannot carry the fault current, then OSHA expects the employer to assume that molten metal or arcing from the faulted conductor could ignite the flammable clothing of a nearby employee. As explained in the note to final paragraph (g)(4)(iii), the employer can presume that conductors do not pose ignition hazards related to molten metal or arcing if they are capable of carrying, without failure, the maximum available fault current for the time the circuit protective devices take to interrupt the fault.

Paragraph (g)(4)(iii) of the final rule, which is being adopted without substantive change from the proposal, requires flame-resistant clothing where "[m]olten metal or electric arcs from faulted conductors in the work area could ignite the employee's clothing." The Southern Company objected to the requirement in proposed paragraph (g)(4)(iii) that employees wear flame-resistant clothing if molten metal could ignite their clothing (Ex. 0212). The company maintained that "it is difficult to determine where molten metal may pose a risk" (*id.*).

OSHA notes that the prepositional phrase "from faulted conductors in the work area" modifies "molten metal" as well as "electric arcs." Thus, employers must provide flame-resistant clothing where employees are working close to equipment, such as pole grounds, that cannot carry fault current. The test is not whether employees are working in areas where an electric arc could eject molten metal onto them; it is whether the employee is working near a conductor that cannot carry fault current. Consequently, OSHA is not adopting the recommendation of Southern Company to eliminate this requirement from paragraph (g)(4)(iii).

Final paragraph (g)(4)(iv) provides that, if the incident heat energy estimated under paragraph (g)(2) exceeds 2.0 cal/cm^2, then the employer must ensure that employees wear flame-resistant clothing.

The foregoing explanation is not an exhaustive discussion of all of the scenarios that would require flame-resistant clothing under final paragraph (g)(4). The Agency expects employers to use the hazard assessment required by final paragraph (g)(1) to determine if any of the conditions listed in final paragraphs (g)(4)(i) through (g)(4)(iv) are present.

Many commenters opposed the 600-volt threshold in the requirement for flame-resistant clothing in proposed paragraph (g)(4)(i). (See, for example, Exs. 0128, 0166, 0186; Tr. 537–538.) These commenters argued that severe arc-flash hazards occur at voltages lower than 600 volts. For example, Mr. Paul Hamer commented:

> Many systems and equipment operating at 600 volts and below have severe arc-flash hazards and [require] the use of flame-resistant clothing for personnel protection. Low-voltage motor control centers, panelboards, switchboards, and switchgear are commonly used in electrical power generation, transmission, and distribution systems. See the requirements of NFPA 70E–2004, which include systems operating at 600 volts and below. [Ex. 0228]

TVA recommended lowering the threshold to 480 volts, explaining:

> Our conclusion is that FR clothing must be worn to protect employees from arc flash hazards on circuits operating at 480 V or more. We have experienced serious injuries in accidents involving 480 V circuits. In 23 arc flash accidents recorded between 1981 and 2003 in our company, 52 percent (23 cases) [were] on 480 V circuits. The 1584 IEEE Guide for Performing Arc-Flash Hazard Calculations lists in its Annex C, 49 arc flash cases. Of these cases, 46 percent of the accidents involved either 480 V or 600 V systems. These statistics show that employees working on circuits operating at 480 V or 600 V are at a significant risk of arc flash injury.
>
> We believe the 480 V arc flash hazard is as great as or greater than the higher voltage arc flash hazard. At transmission voltages, the arcs generally present a lower risk of injury because of the distance the employee is to the arc (MAD), the arc being phase-to-ground, the arc being in open air, and the other reasons stated in our comments to other sections of this rule. The magnitude of the heat energy in 480 V arc flash accidents is greater because of the following:
>
> 1. The single phase fault typically propagates to three phase fault.
> 2. The clearing times in generating plants are typically longer.
> 3. The arc flash energy is typically forced into one direction (arc in a box).
>
> It is recommended that the final rule require the employee to wear flame resistant clothing any time he or she is subject to contact with live parts energized at 480 V or more. [Ex. 0213]

These commenters misunderstood the proposed rule. Paragraph (g)(3) of the final rule contains a prohibition against wearing clothing that could melt onto an employee's skin or that could ignite and continue to burn when exposed to flames or the incident heat energy estimated under final paragraph (g)(2). Thus, final paragraph (g)(3) indirectly requires flame-resistant clothing when the incident heat energy could melt clothing onto an employee's skin or ignite an employee's clothing. Paragraph (g)(4) of the final rule supplements paragraph (g)(3) and requires flame-resistant clothing under other conditions likely to ignite flammable clothing. Thus, final paragraph (g)(4)(i) requires flame-resistant clothing when an employee is exposed to contact with energized parts operating at more than 600 volts, regardless of the estimated incident heat energy.

NFPA 70E–2004 Section 130.3 requires employers to conduct an arc-flash hazard analysis and determine the arc-flash protection boundary to protect employees from being injured by electric arcs (Ex. 0134).[350] That section defines the arc-flash protection boundary as the distance at which the incident energy equals 1.2 cal/cm^2 or, if the clearing time is 0.1 seconds (6 cycles) or less, 1.5 cal/cm^2 (*id.*). A few commenters urged the Agency to consider an arc-flash boundary requirement similar to the one in NFPA 70E. (See, for example, Exs. 0128, 0130, 0235.) For instance, the Dow Chemical Company commented:

> Dow recommends that OSHA change the trigger for wearing FRC from "contact with energized circuit parts operating at more than 600 volts" to "work within the electric arc flash hazard distance when there is a substantial potential for an arc flash" . . . . NFPA 70E uses the electric arc flash hazard distance as the trigger for wearing FRC, and it provides guidance in how to determine the electric arc flash hazard distance. [Ex. 0128]

In response to these comments, OSHA is adding a requirement, in final paragraph (g)(4)(iv), that employees wear clothing that is flame-resistant where the incident heat energy estimated under final paragraph (g)(2) exceeds 2.0 cal/cm^2. Although NFPA 70E–2004 sets the arc-flash protection boundary at lower levels, Section 130.7(C)(14)(b) of that standard [351]

[350] Section 130.5 of NFPA 70E–2012 contains an equivalent requirement.

[351] NFPA 70E–2012 no longer explicitly permits "nonmelting flammable materials" for exposures from 1.2 to 2.0 cal/cm^2; however, NFPA 70E–2012 Table 130.7(C)(15)(b) apparently permits such fabrics for certain exposures above 1.2 cal/cm^2. Consequently, the latest edition of NFPA 70E does not conflict with OSHA's decision to require flame-

permits employees to wear "nonmelting flammable natural materials" (in lieu of flame-resistant clothing) where the incident-energy level is 2.0 cal/cm² or less.[352] New paragraph (g)(4)(iv) should make it clear that employees must wear flame-resistant clothing whenever the incident heat energy would be sufficient to ignite flammable clothing, regardless of voltage. For consistency, OSHA is making a corresponding change in final paragraph (g)(5), which requires employers to 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 final paragraph (g)(2) *whenever that estimate exceeds 2.0 cal/cm².* The Agency believes that final paragraphs (g)(4)(iv) and (g)(5) must have the same incident-energy threshold; otherwise, the final rule would require clothing to be arc rated, but not flame resistant, when the estimated incident energy was 2.0 cal/cm² or less. (As noted under the summary and explanation for final paragraph (g)(5), later in this section of the preamble, all arc-rated clothing is flame resistant. Thus, if the final rule required arc-rated clothing when the estimated incident energy was 2.0 cal/cm² or less, it also would effectively require flame-resistant clothing at these exposures.) Therefore, under the final rule, whenever paragraph (g)(4)(iv) requires clothing to be flame resistant, that clothing must also have an arc rating under paragraph (g)(5).

Selecting arc-rated protective clothing and other protective equipment. Paragraphs (g)(3) and (g)(4) of final § 1926.960 will protect workers against burns from the ignition or melting of clothing. These provisions do not address the protection of workers from the incident heat energy in an electric arc, which is the purpose of paragraph (g)(5).

Much of the flame-resistant clothing available today comes with an arc rating.[353] In basic terms, an arc rating indicates that a fabric should not transfer sufficient thermal energy to cause a second-degree burn when tested under standard laboratory conditions that expose the fabric to an electric arc that radiates an energy at or below the rating.[354] Proposed paragraph (g)(5) would have required that employees exposed to hazards from electric arcs wear clothing with an arc rating greater than or equal to the heat energy estimated under paragraph (g)(2). This clothing will protect employees exposed to heat energy from sustaining severe burn injuries in areas covered by the clothing.

Several rulemaking participants argued that OSHA should not require protection based on unreliable estimates of incident energy. (See, for example, Exs. 0183, 0229, 0233.) For instance, Mr. Jonathan Glazier with NRECA commented:

> [E]stimates of maximum amounts of heat energy are inherently unreliable. Accordingly, such estimates do not provide an adequate foundation for a protective clothing requirement. In other words, it makes no sense to require clothing to protect against second degree burns from an amount of energy that cannot be calculated reliably. For that reason, OSHA should drop the protective clothing requirement of 1910.269(l)(11)(v) and 1926.960(g)(5). [Ex. 0233]

As explained under the discussion of final paragraph (g)(2) earlier in this section of the preamble, OSHA concludes that there are incident heat energy calculation methods that can provide reasonable estimates of incident energy for all types of arc exposures employees experience. Therefore, the Agency concludes that it is reasonable to select arc-rated clothing and other protective equipment on the basis of those estimates.

EEI argued that "OSHA has not shown that the risk of harm would be materially reduced by using the methods specified in the proposal" and that "there simply is not substantial evidence that wearing clothing with an appropriate arc rating . . . would eliminate or substantially reduce employee exposure to a burn injury from a flame or electric arc" (Ex. 0227).

OSHA disagrees with EEI. There is substantial evidence in the record that selecting protective clothing and other protective equipment with an arc rating based on a reasonable estimate of incident energy will substantially reduce injury from electric arcs. To understand how arc-rated clothing and other protective equipment substantially reduces injury, one must first examine how burn injuries occur. The skin absorbs heat energy; and, after absorbing a certain amount of energy, the skin sustains burn injury. According to Dr. Thomas Neal, the human body begins to get a burn at 1 to 2 cal/cm² (Tr. 433). At low levels of heat, the body sustains a first-degree burn, like a sunburn, with redness and minor pain, but no blistering. An incident heat energy level of 1.2 cal/cm² is the threshold at which the burn injury becomes a second-degree burn (Exs. 0134, 0425). Second-degree burns involve swelling and blisters, along with greater pain and redness. As the skin absorbs more energy, the burn gets worse, involving more layers of skin, until it reaches a full-thickness, or third-degree, burn. The most serious burns require prolonged hospitalization and skin grafts and result in permanent scarring (Ex. 0373; Tr. 219).

Figure 11 shows a simplified diagram of a worker exposed to an electric arc.[355] This diagram shows the boundary (depicted by a broken circle) where the estimated incident energy equals a clothing rating that meets, but does not exceed, the rating required by final paragraph (g)(5). Inside the broken circle, the incident energy is greater than the estimate; outside the circle, the incident energy is less than the estimate.

resistant clothing for estimated incident heat energy exposures exceeding 2.0 cal/cm².

[352] Although OSHA has not stated the requirement in final paragraph (g)(4)(iv) in terms of a boundary, the area inside which flame-resistant clothing is required extends to the boundary where the estimated incident energy equals 2.0 cal/cm².

[353] The ASTM standards governing arc rating require the tested fabric to be flame resistant. Thus, no non-flame-resistant clothing has an arc rating.

[354] ASTM F1506–02a^{e1}, *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:* defines "arc rating" as "the maximum incident energy (E_i) resistance demonstrated by a material prior to breakopen or at the onset of a second-degree burn" (Ex. 0061). The latest version of that consensus standard, ASTM F1506–10a, contains a differently worded, but equivalent definition.

[355] In all likelihood, an electric arc would be larger than the small-diameter sphere depicted in Figure 11. However, the estimated energy is the same at all points that are the same distance from the arc, and the diagram is valid for any spherical arc.

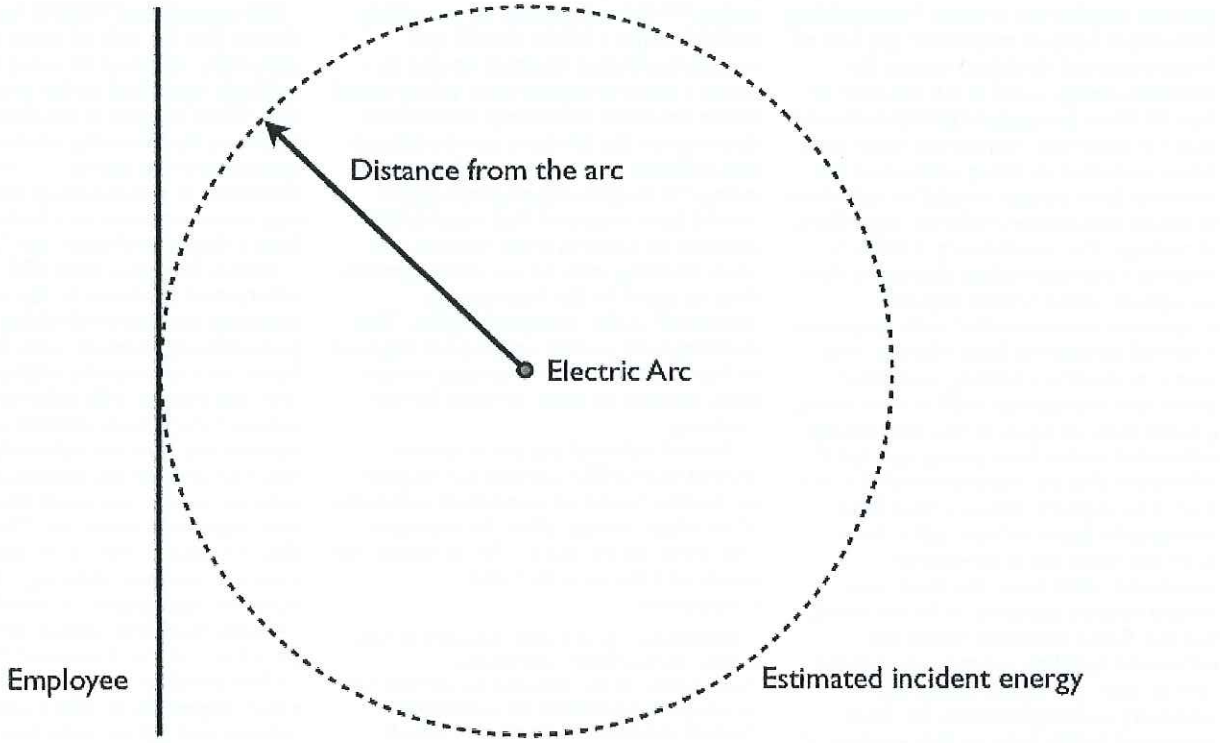

Figure 11—Employee Exposed to Electric Arc

The arc rating of protective clothing and other protective equipment is an indication of the relative protection it provides from incident energy. Dr. Thomas Neal explained that "the arc rating . . . is defined as the level of . . . exposure at which you would expect 50 percent probability of a burn injury" (Tr. 444). The ASTM standard clarifies that the rating is at "the onset of a second-degree bum" (Ex. 0061). Thus, in Figure 11, the employee has a 50-percent chance of barely receiving a second-degree burn at the point where the broken circle touches the employee. (That is, the probability that the incident energy will be equal to or greater than 1.2 cal/cm^2 is 50 percent.) As Dr. Neal explained, the chance of barely sustaining a second-degree burn drops quickly with a reduction in incident energy (Tr. 443–445). The probability of receiving a second-degree burn while wearing a particular arc-rated garment typically drops to 1 percent with a reduction in incident energy of a few calories below the arc rating of the clothing (*id.*). For example, with the NFPA 70E Annex D method, the incident energy is inversely proportional to the square of the distance from the arc to the employee. If the distance from the arc to the employee is 455 millimeters (18 inches), the incident energy drops nearly 10 percent at a distance of 150 millimeters (6 inches) from the point where the circle touches the employee.

From this, OSHA concludes that an employee wearing arc-rated protection in accordance with the final rule should receive, at worst, a second-degree burn over a relatively small portion of his or her body at the estimated incident-energy level. In addition, because arc-rated clothing and other protective equipment that complies with final paragraph (g)(5) will block a substantial portion of the heat energy, any injury that occurs will be substantially less severe than would occur without arc-rated protection at all or with arc-rated protection with a rating lower than the estimated heat energy. Consequently, the Agency concludes that the severity of injury will be reduced when an employee is wearing protective clothing and other protective equipment with an arc rating greater than or equal to the actual incident-energy level experienced by the employee. Although an employee will receive a more severe burn injury if the incident energy exceeds the arc rating of the protection than if it does not, OSHA concludes that estimates of incident heat energy prepared in compliance with final paragraph (g)(2) will relate reasonably well to the incident energy actually experienced by employees in the event of an arc. Also, even if the incident energy actually exceeds those estimates, arc-rated protection will still reduce the extent and degree of injury (see Tr. 535: "MR. WALLIS [asking question]: 'Would arc [rated] clothing reduce the extent and degree of injury, even if the arc energy is higher than the employer's estimate?' DR. NEAL [responding]: 'Yes, it would.'"). The reduction in these effects occurs because arc-rated protective clothing and other protective equipment blocks the amount of heat that gets through to the employee's skin (Tr. 471–472).

Protecting the entire body. OSHA did not propose to require a specific level of protection for skin not covered by clothing. However, in the preamble to the proposal, the Agency requested comments on whether the standard should require protection for an employee's entire body.

TVA recommended that the rule address unprotected skin as follows:

> Due to our experience with arc flash accidents, we believe that the employee's hands and arms require some level [of] protection. Our procedure requires the employee to wear the long sleeved FR shirt with the sleeve down and buttoned. [W]e do not consider a short sleeve FR shirt to provide adequate arc flash protection to the employee's arms. We also require employees to wear leather gloves or voltage rated gloves with leather protectors when in arc flash

exposure situations. The electric utility industry has arc flash exposures that could result in 3rd degree burns to unprotected parts of the body that could cause serious injury. It is recommend[ed] that the final rule require employees to wear a long-sleeved FR shirt with its sleeve[s] down and buttoned in potential arc flash situations. The rule should also require leather gloves, if voltage rated gloves are not being worn. [Ex. 0213]

Forty-six of the 100 arc-related burn accidents in Exhibit 0004 involved burn injuries to an employee's arms.[356] Five of those 100 accidents involved burns to an employee's leg.[357] Forty of those 100 accidents involved burns to an employee's head.[358] The accidents in the rulemaking record and TVA's experience clearly indicate a need to protect all parts of the employee's body. Employees with uncovered skin are at risk of severe injury or death. Requiring protection only for areas covered by clothing would lead to the absurd possibility that an employer would be in compliance if an employee worked without clothing. Therefore, OSHA concludes that the standard should address not only the rating of the clothing, but the extent of protection needed for the employee's body. Accordingly, paragraph (g)(5) in the final rule requires that, when employers must provide arc-rated protection to employees, the protection must cover the employee's entire body, with a few exceptions described later.

There is evidence in the record that some types of nonarc-rated clothing and protective equipment provide suitable protection from arc-related burn injuries on areas not typically covered by clothing, for instance, the hands and feet. (See, for example, Exs. 0186, 0212, 0213; Tr. 433–435.) As noted in the preamble to the proposal, although neither rubber insulating gloves nor leather protectors have arc ratings, their weight and thickness typically provide greater protection from electric arcs than light-weight flame-resistant clothing (70 FR 34868). The accident data support this conclusion—none of the burn injuries to employees' hands described in the record involved an employee wearing rubber insulating gloves. In addition, NFPA 70E–2004 recognizes the protection afforded by rubber insulating gloves (Ex. 0134). Heavy-duty leather work gloves with a weight of 407 gm/m^2 (12 oz/yd^2) provide protection up to about 14 cal/cm^2 (Ex. 0134; Tr. 434).[359] Therefore, the final rule recognizes the protection afforded by rubber insulating gloves with protectors, as well as heavy-duty leather work gloves. Under final paragraph (g)(5)(i), the employer need not ensure the use of arc-rated protective gear over the employee's hands when the employee wears rubber insulating gloves with protectors or, if the estimated incident-energy exposure is 14 cal/cm^2 or lower, if the employee wears heavy-duty leather work gloves with a weight of at least 407 gm/m^2 (12 oz/yd^2).

NFPA 70E recognizes "[h]eavy-duty work shoes" as providing "some arc flash protection to the feet" and generally requires this type of shoe when the exposure is above 4 cal/cm^2 (Ex. 0134).[360] As OSHA found no evidence in the record of an employee sustaining burn injuries to the feet in an arc-related accident, the final rule recognizes the protection afforded by heavy-duty work shoes. Final paragraph (g)(5)(ii) provides that employees wearing heavy-duty work shoes or boots do not need to use arc-rated protection on their feet.

Many rulemaking participants opposed requiring arc-rated protection for the head,[361] arguing that faceshields could interfere with vision and make the work more dangerous. (See, for example, Exs. 0167, 0175, 0186, 0233.) For instance, Ms. Salud Layton with the Virginia, Maryland & Delaware Association of Electric Cooperatives commented, "Employing the use of a faceshield may cause more of [a] hazard than benefit by reducing peripheral vision and nuisance distraction to the employee while work is being performed on energized facilities" (Ex. 0175).

Other rulemaking participants supported a requirement for faceshields or other forms of arc-rated head and face protection. (See, for example, Exs. 0130, 0241; Tr. 461–463.) NIOSH explained their position as follows:

> NIOSH recommends that the use of arc-rated face protection be included in sections 1910.269(l)(11) and 1926.960(g)(5). An arcing-fault can injure an employee's face and eyes, and typical non-arc-rated safety eyewear is inadequate. Arc-rated face shields and hoods are available that offer protection levels that can be matched to the rating of any arc-rated fire resistant clothing. NFPA 70E–2004 requires a wraparound face shield of appropriate arc-rating that protects forehead, ears, and neck . . . for heat energy exposure levels above 4 calories/cm^2, and a flash suit hood of appropriate arc-rating . . . for levels above 8 calories/cm^2 (see NFPA 70E–2004, page 33, table 130.7(C)(10)). [Ex. 0130]

IBEW supported a requirement for arc-rated head and face protection, but only in certain circumstances (Exs. 0230, 0505). The union explained its position and rationale as follows:

> IBEW submits that while face shields may provide effective protection in some work environments, they are not appropriate means of protection for all aspects of transmission and distribution work.
>
> [F]ace shields are designed to be attached to the employee's hard hat. . . . They provide a complete shield from above the employee's forehead to below his or her chin. Because they only protect the front of the employee's head, however, Dr. [Thomas] Neal recommends that they be worn in combination either with a "bee keeper's hood," of the type used by firefighters, or with a lighter-weight and cooler advancement, a balaclava, or ski-type mask. . . .
>
> Dr. Neal testified that although he knows utilities have purchased face shields, he does not know how they have been used. In particular, he could not say whether they are being used by anyone doing line work. Nor did he have any familiarity with what it would be like to perform line work while wearing the face shield, either alone or in combination with a balaclava. . . .
>
> A face shield is appropriate PPE for an electrician in a power plant racking a breaker in or out of its enclosure. In that situation, it usually takes only minutes to accomplish the task. Further, the electrician would generally be on solid footing—either on the plant floor or a platform—when wearing the shield to perform the energized work. The shield is also practical PPE when setting or removing a meter, where, again, the

[356] See, for example, the nine accidents described at *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=170097497&id=170054258&id=170614002&id=14225569&id=201140522&id=170152540&id=170071138&id=170738165&id=170250062.*

[357] See the five accidents described at *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=170361026&id=170389811&id=201791803&id=144901144&id=596304.*

[358] See, for example, the nine accidents described at *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=170097497&id=170054258&id=14225569&id=170631469&id=170071138&id=170738165&id=170611057&id=200962322&id=170764021.*

[359] In a note to Section 130.7(C)(13)(c), NFPA 70E–2004 states that "[i]nsulating rubber gloves . . . provide hand protection against the arc flash hazard" (Ex. 0134). OSHA anticipates that there is a limit to the amount of protection afforded by rubber insulating gloves, but there is no information in the record to indicate what that limit might be. However, that section in the NFPA standard requires leather protectors to be worn over rubber insulating gloves for purposes of arc-flash protection. (NFPA 70E–2012 contains an equivalent requirement and note.)

[360] NFPA 70E–2004 requires heavy-duty work shoes for tasks in hazard-risk category 2 and higher (Ex. 0134). Table 130.7(C)(9)(a) generally requires hazard-risk category 2 protection when the incident energy is more than 4 cal./cm^2, but less than 8 cal./cm^2 (*id.*). NFPA 70E–2012 additionally requires heavy-duty work shoes for "all exposures greater than 4 cal/cm^2."

[361] In the preamble and regulatory text, the term "protection for the head" means protection for the entire head, from the neck up. It includes protection for the neck, face, and ears. In contrast, the term "head protection" as used in §§ 1910.135 and 1926.100 and in final § 1910.269 and subpart V, means protection provided for the head by a hardhat, which generally does not protect the face or neck.

employee would be donning the face shield for a short period of time.

These two work situations sharply contrast with that of climbing a pole, working up a pole surrounded by wires, braces, brackets, and transformers, and descending the pole. In these types of work situations, wearing the face shield for lengthy periods would create additional safety problems, including issues with mobility, heat, and vision, that could more than offset the shield's arc protection factor.

To summarize, although face shields are designed to provide important protection against arc flash hazards, the record fails to demonstrate the feasibility of requiring them in every instance of energized work. Indeed, simply examining the conditions under which employees work on electrical lines shows that it would be impractical to require their use as PPE in all situations. [Ex. 0505]

OSHA agrees with IBEW that wearing arc-rated head and face protection is likely to cause more problems for overhead power line work than for in-plant work. For instance, faceshields and other forms of arc-rated head and face protection potentially can interfere with climbing and descending a pole (Ex. 0505). However, the Agency does not believe that this interference necessarily creates a greater hazard. Power line workers generally must wear hardhats under existing §§ 1910.135 and 1926.100. Because it is suspended below the employee's hardhat, a faceshield does not extend significantly beyond the edge of the hardhat. Consequently, a faceshield worn alone with a hardhat should not be substantially more of an impediment to climbing than the hardhat alone. Perhaps a beekeeper-type hood, which extends on all sides beyond a hardhat, would interfere more substantially with climbing and descending poles; however, Dr. Neal noted that newer forms of arc-rated protection, such as a balaclava (a garment that looks like a ski mask and that an employee wears beneath a hardhat), can provide nearly the same protection as a hood without the hood's bulk (Tr. 438–440). In addition, as discussed in the summary and explanation for final § 1926.954(b)(3)(iii), the final rule generally requires employers to protect employees against falling while climbing or descending poles. Therefore, OSHA concludes that suitable head protection should not interfere with climbing or descending poles enough to pose a significant hazard.

If an employee is working so close to "wires, braces, brackets, and transformers" that a faceshield would interfere with his or her performance, as IBEW argues, the objects would also be close enough to endanger the employee's face as the employee is working. In any event, it is unclear how a faceshield, or even a faceshield with a balaclava, would interfere significantly with the mobility of an employee performing overhead line work. Thus, OSHA concludes that employers can find suitable head and face protection that will interfere minimally with a worker's mobility and allow the worker to perform his or her job safely and efficiently, without posing a significant hazard to the worker.

As discussed later in this section of the preamble, OSHA examined the heat stress issue raised by some commenters and concludes that, although heat stress can be a significant hazard, there are feasible means of abating the hazard for employees wearing arc-rated protective garments and head and face protection. In fact, Dr. Neal testified that faceshields would not contribute significantly to heat-stress hazards because "air is going to be moving inside the shield" (Tr. 478). As explained later, employers need not use arc-rated head protection or a faceshield until the estimated incident-energy level is greater than or equal to 9 cal/cm^2 for most forms of overhead line work. At higher levels, employers must take heat-stress abatement measures when warranted by environmental conditions.

A beekeeper-type hood likely would interfere with peripheral vision. However, as noted earlier, employers can achieve similar protection with a faceshield and balaclava combination, which should not interfere with an employee's peripheral vision.

Dr. Neal noted that clear faceshields do not provide much protection from arc-related burn injuries, however (Tr. 433–434). In response to questions about whether arc-rated faceshields could reduce visibility, especially at night, Dr. Neal testified:

MR. BYRD: Does that shield—Is that designed primarily for daylight work?

DR. NEAL: Well, it's designed for work where you have light, yes. Could be daylight; it could be artificial light.

MR. BYRD: I guess what I'm asking: If I had a car break a pole off at two o'clock in the morning and I'm having to wear some kind of shield, do I have to have a tinted shield and also a clear shield? Do you make the clear shields as well?

DR. NEAL: Yes, I think there are companies that make both types of shields. But, no, the clear shield is—The tinted shield takes care of the function of the clear shield, which is actually to protect you from projectiles.

MR. BYRD: Well, I guess what I'm looking at is visibility in repairing that pole and the lines that are energized. If I have a shield on that is designed for daylight and I put that in, it's kind of like sunglasses or your safety glasses that are tinted. If I put those on at night, I'm totally blind now. So I would have to have a shield for nighttime use as well.

DR. NEAL: Well, those sunglasses actually are much darker than the shield that I had here. It's not really designed for day work, but you may find that—You know, I think when you are doing work at night, you have to add light in most cases.

MR. BYRD: We do.

DR. NEAL: Yes. So I think whatever you add for doing the work normally would suffice for most of the shields. It's something you would have to try, and you would say, well, no, I'm not getting enough light. So you may have to do something different there. [Tr. 511–513]

Based on this evidence, OSHA concludes that employers can find suitable arc-rated head and face protection that does not significantly interfere with an employee's vision and that normally does not require supplemental lighting beyond what they would otherwise supply.

For the foregoing reasons, OSHA concludes that suitable arc-rated head and face protection does not necessarily pose greater hazards than working without it and that a requirement for employees to wear such protection when warranted by arc hazards generally will be technologically feasible and reasonable for overhead line work. Because the evidence, including IBEW's comments, suggests that overhead line work is the most problematic type of work for purposes of wearing arc-rated head and face protection, the Agency comes to the same conclusion for the other types of work addressed by § 1910.269 and Subpart V.

Dr. Neal testified that he believed that employees should wear head and face protection "[a]nytime there is a risk of a heat exposure over [1.5 to] 2 calories, . . . where you are just on the edge of getting a second degree burn" (Tr. 462). He also noted, however, that his opinion is at odds with "some of the standards that exist today, [in which] this is not required until you get to about 8 calories" (*id.*). For instance, Table 130.7(C)(10), Protective Clothing and Personal Protective Equipment (PPE) Matrix, in NFPA 70E–2004, requires faceshields for hazard-risk category 2, which generally corresponds to an incident-energy level of 5 to 8 cal/cm^2, and flash-suit hoods for hazard-risk category 3 and higher, which generally corresponds to an incident-energy level of 9 cal/cm^2 and higher (Ex. 0134).[362]

[362] NFPA 70E–2012, in Table 130.7(C)(16), requires an arc-rated faceshield for hazard-risk category 1, which generally corresponds to an incident-energy level of 1.2 to 4 cal/cm^2, and an arc-rated flash suit hood or arc-rated faceshield and arc-

For the three-phase exposures addressed by the incident-energy calculation methods given in NFPA 70E–2004, Annex D, the Agency concludes that these are reasonable thresholds for requiring head and face protection (*id.*).[363] It is apparent that NFPA 70E–2004 Table 130.7(C)(10) sets protective equipment requirements for the worst-case exposures for the methods in Annex D of that standard, that is, exposures involving three-phase arcs in enclosures. The Agency believes that such exposures are more likely to involve convective heat energy, which can transfer to the area behind a faceshield, and to involve the back of the head due to reflected heat energy. In addition, Annex D presumes a distance from the employee to the arc of 455 millimeters (18 inches).

As explained previously in this section of the preamble, much overhead line work poses hazards involving exposure to single-phase arcs in open air. In such exposures, there is little or no reflected or convective heat energy. In addition, as also noted earlier, OSHA concluded that a reasonable distance from the employee to the arc for these exposures is 380 millimeters (15 inches), measured from the crotch of the employee's hand to the chest.[364] (See Table 14, earlier in this section of the preamble.) OSHA estimates that the employee's face will likely be at least 455 millimeters (18 inches) from the arc.[365] Because the heat energy from a single-phase arc in air drops in inverse proportion to the square of the distance, the roughly 20-percent increase in distance (from 380 to 455 millimeters) results in a drop in incident energy of nearly 30 percent (Ex. 0430). Therefore, because the incident energy at the employee's head will be more than 30 percent lower than the estimated incident energy, which OSHA based on the exposure at the employee's chest, OSHA concludes that the thresholds for requiring head and face protection for exposures involving a single-phase arc in air can be higher than the threshold for requiring head and face protection for three-phase exposures. The final rule adopts the following ranges for head and face protection:

Exposure	Minimum head and face protection		
	None *	Arc-rated faceshield with a minimum rating of 8 cal/cm² *	Arc-rated hood or faceshield with balaclava
Single-phase, open air	2–8 cal/cm²	9–12 cal/cm²	13 cal/cm² or higher †.
Three-phase	2–4 cal/cm²	5–8 cal/cm²	9 cal/cm² 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/cm² 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/cm² 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.

OSHA chose the 5- and 9-cal/cm² thresholds for three-phase arcs to match the thresholds in NFPA 70E–2004, as recommended by NIOSH (Ex. 0134). The 9- and 13-cal/cm² thresholds for exposures involving single-phase arcs in open air account for the lack of reflected and convective heat on the employee's head, as well as the 30-percent reduction in incident energy expected at the employee's head.

Final paragraph (g)(5)(iii) does not require arc-rated protection for the employee's head when the employee is wearing head protection meeting § 1926.100(b)(2) and 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. Final paragraph (g)(5)(iv) permits the employer to protect the employee's head using a faceshield with a minimum arc rating of 8 cal/cm² if the employee is wearing head protection meeting § 1926.100(b)(2) and 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. Paragraph (g)(5)(v) permits a reduction of 4 cal/cm² in the arc rating of head and face protection for single-phase arcs in open air (the difference between the two sets of thresholds). For example, if the estimated incident energy for an exposure involving a single-phase arc in open air is 13 cal/cm², the head protection provided to the employee must have an arc rating of at least 9 cal/cm².

Other issues relating to the selection of protective clothing and other

rated balaclava for hazard-risk category 2 and higher, which generally corresponds to an incident-energy level of 5 to 8 cal/cm². However, as explained later in this section of the preamble, this edition of NFPA 70E does not account for any reduction in incident heat energy at the employee's face in comparison to the level of incident heat energy at the working distance (generally the employee's chest). OSHA concludes that not accounting for this reduction would require more protection against incident heat energy than necessary. As explained under the heading *Heat stress,* later in this section of the preamble, heat stress is a genuine concern of many rulemaking participants. Requiring a level of head and face protection higher than the likely incident energy at employees' heads would unnecessarily increase heat stress for employees. As further explained in that section of the preamble, OSHA also concluded that: Heat stress is a widely recognized hazard; employers covered by the final rule already have an obligation under the general duty clause of the OSH Act to abate these hazards; and employers covered by the final rule already are addressing heat-stress issues in their workplaces. Despite these conclusions, the Agency believes that, for work covered by the final rule, paragraphs (g)(5)(iii) through (g)(5)(v) strike a more reasonable balance between the need for protection against incident energy from electric arcs and the need to protect employees against heat stress. The final rule achieves this balance by requiring a level of protection commensurate with the incident energy likely at the employee's head.

Note that OSHA's finding regarding the need for faceshields applies only with respect to their use as protection from incident energy. As noted under the heading *Protecting employees from flying debris from electric arcs,* OSHA's existing general PPE requirements in §§ 1910.132 and 1926.95 require employers to address nonthermal hazards, including physical trauma hazards posed by flying debris, associated with employee exposure to electric arcs.

Note also that OSHA's findings regarding head and face protection apply only to electric power generation, transmission, and distribution work covered by the final rule. NPPA 70E–2012, like subpart S of OSHA's general industry standards, requires employers to deenergize electric circuits before employees work on them except under limited circumstances. Thus, heat stress hazards for work performed under NFPA 70E–2012 and Subpart S should not be as pervasive as under this final rule, which generally permits employees to work on energized circuits without restriction.

[363] NFPA 70E–2004, Annex D describes the Doughty, Neal, and Floyd and IEEE 1584 methods in addition to the Lee method. See the summary and explanation for final paragraph (g)(2), earlier in this section of the preamble, for a discussion of these methods (Ex. 0134). Annex D in NFPA 70E–2012 adds a method, from the NESC, for single-phase arcs in open air.

[364] OSHA concluded that 380 millimeters (15 inches) is a reasonable distance for rubber insulating glove work. For work with live-line tools, OSHA concluded that the distance is greater than 380 millimeters. (See the summary and explanation for final § 1926.960(g)(2) earlier in this section of the preamble.)

[365] With the employee's hands out directly opposite the chest, the distance from the chest to the arc is 380 millimeters (15 inches), and the distance vertically from that point on the chest to the employee's chin is about 255 millimeters (10 inches). The distance from the chin to the arc is the hypotenuse of the right triangle with those two sides, or about 455 millimeters (18 inches).

protective equipment. Ms. Susan O'Connor with Siemens Power Generation contended that there were factors to consider other than incident heat energy in the selection of arc-rated protection, commenting:

We do not believe that protective clothing decisions should be made solely based on a numerical calculation—especially when such calculation methods are suspect as to their range of error. There are certainly hazards that would be created by utilizing this equipment. This clothing is heavy, hot, and bulky. It is not unreasonable to foresee that heat stress, and injuries related to lack of mobility or visibility would increase when using this equipment. Likewise, the heat calculations make no allowances for the inherent risk of a task. Opening a bolted panel on a piece of equipment is riskier than opening a hinged panel. (A bolted panel could be fumbled into live bus causing a fault, while this is nearly impossible with a hinged panel). Racking a breaker out with the enclosure door open is riskier than with the door closed. (The closed door will contain much of the fault energy should it occur thereby protecting the employee) However, if we rely solely on the heat calculation these two sets of scenarios would require identical PPE. [Ex. 0163]

As explained earlier, OSHA already considered issues related to the mobility and vision of workers using arc-rated head and face protection and concluded that such items generally will not create more hazardous conditions for employees. For similar reasons, the Agency also concludes that mobility is not generally a concern for arc-rated protection. Even the highest-rated clothing is not significantly heavier than winter weather clothing (see, for example, Tr. 440 [366]), and line workers are currently performing tasks in winter clothing in cold weather. In addition, evidence in the record indicates that at least one utility requires its employees to use some of the heaviest weights of arc-rated clothing, and this utility did not report any problems with worker mobility (Exs. 0213, 0215). As explained later in this section of the preamble, the Agency also concludes that heat stress should not affect the selection of arc-rated protection under final paragraph (g)(5) as there are other ways of mitigating that hazard when necessary.

As discussed under the summary and explanation for final paragraph (g)(2), earlier in this section of the preamble, OSHA concluded that it is unreasonable to reduce estimated incident-energy levels simply because an employee is working in a situation in which there is a low risk that an electric arc will occur. The Agency similarly concludes that it unreasonable to select arc-rated protection based on how likely an arc is to occur. OSHA does not dispute that there is a higher risk of an arc occurring when an employee is racking a circuit breaker than when an employee is opening a hinged panel.[367] Three of the arc-related burn accidents in Ex. 0004 occurred as employees were racking breakers.[368] None of the burn accidents involved an employee opening or closing a hinged cover on enclosed equipment. As explained in the summary and explanation for final paragraph (g)(2), if there is no reasonable likelihood that an electric arc will occur, OSHA will consider the employee to have no electric-arc exposure, and the employer need not provide the protection required under final paragraph (g)(4)(ii), (g)(4)(iv), or (g)(5).[369] OSHA believes that opening a hinged cover on a dead-front panelboard generally would not result in employee exposure to electric-arc hazards under final paragraph (g)(2). However, if there is a reasonable likelihood that an electric arc will occur in the employee's work area, then protection against the full incident heat energy of the arc is necessary. Otherwise, when an arc does occur, the employee could receive severe burn injuries.

Three commenters wanted OSHA to clarify that paragraph (g)(5) only requires protection to the extent that compliant clothing is reasonably available (Exs. 0170, 0222, 0237). These commenters expressed concern that the standard would require employers to implement potentially costly abatement measures to reduce incident energy to levels for which clothing is available (*id.*). For example, Mr. Chris Tampio with the National Association of Manufacturers commented:

The proposal does not explain how the rule would be interpreted in situations where compliance with the proposed arc-rated clothing requirements is infeasible because there is no clothing available to protect against that level of heat energy (and still permit the employee to perform the required work). We believe it is critical that OSHA clarify that compliance with the proposed rule would be considered infeasible under those circumstances, and that the agency would not require the employer to exhaust other feasible measures. Otherwise, we are concerned that employers could be required to engage in very expensive retrofitting of electrical installations so as to reduce the maximum heat energy that might be released by an arc flash to a level where suitable [flame-resistant or arc-rated] clothing would be reasonably available.

The extremely costly measure of retrofitting equipment is not accounted for in the agency's economic analysis for this rulemaking, would substantially raise the costs of compliance with the proposed standard, and might invalidate the agency's entire economic analysis for this proposal. OSHA has a duty to promulgate rules that are both technically and economically feasible, and a duty to base its decisions on the best available information relating to the economic consequences of the intended regulation. Executive Order . . . No. 12866, titled "Regulatory Planning and Review", . . . include[s] a requirement that each agency assess both the costs and the benefits of the intended regulation and, recognizing that some costs and benefits are difficult to quantify, propose or adopt a regulation only upon a reasoned determination that the benefits of the intended regulation justify its costs. Additionally, the U.S. Supreme Court and various Courts of Appeals have held that OSHA regulations must be technically *and economically* feasible. . . .

In order to meet these legal requirements, OSHA must either clarify that no retrofitting is required or adequately address the economic impact of retrofitting electrical equipment due to the infeasibility of providing protective equipment and clothing that can withstand arc-flash hazards. [Ex. 0222; footnotes omitted; emphasis included in original.]

The final rule generally requires that employers provide protection with an arc rating at least as high as the incident energy estimated under final paragraph (g)(2). When the initial estimated incident energy is extremely high, employers can either provide protection with an arc rating that is at least as high as the estimate or take measures to reduce the estimated incident energy. Those measures include changes to the installation and changes to work procedures. For example, installing current-limiting fuses is one way that will reduce incident energy by changing the installation (Tr. 498), and performing the work from a remote position (Tr. 499) and installing heat-shielding barriers (Tr. 210, 266) are ways that will reduce incident energy by changing work procedures.

The Agency examined the rulemaking record and concluded that retrofitting would rarely be necessary to permit compliance with this final rule. Employees perform much of the work covered by the final rule on overhead

[366] According to Dr. Thomas Neal, manufacturers make suits rated at 100-cal/cm² from material weighing 610 gm/m² (18 ounces/yd²) (Tr. 440). That weight is less than twice the weight of denim material, which is about 375 gm/m² (11 ounces/yd²) (269-Ex. 12–12. See, also, 59 FR 33659).

[367] Racking a circuit breaker is the process by which a circuit breaker is inserted and removed from the circuit breaker cubicle.

[368] See the three accidents described at *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=14328736&id=200962322&id=170197156.*

[369] Paragraphs (g)(4)(i) and (g)(4)(iii) involve exposures that OSHA has determined expose employees to electric arcs or flames, namely, contact with energized circuit parts operating at more than 600 volts and molten metal or electric arcs from faulted conductors in the work area that could ignite the employee's clothing.

transmission and distribution lines. Several rulemaking participants noted that work on the vast majority of overhead line installations will not require the highest-rated protection available. Mr. James Tomaseski, representing IBEW testified:

> From the tables that are proposed in Appendix F, . . . we looked at those as common exposures out on distribution lines. [I]n discussions that I have had with utility employers and engineers, and so forth, about these values, I have not heard anybody yet say that they would have to be in hoods working on their distribution circuits" (Tr. 939–940).

There is no evidence in the record that estimated incident-energy values for overhead power line installations are likely to exceed the values in Table 6 and Table 7 in final Appendix E. The highest estimated incident-energy level listed in those tables is 12 cal/cm², and protection with this rating is readily available (see, for example, Tr. 412–414).

Underground distribution systems potentially expose employees to higher incident-energy levels. IBEW noted, for example, that "replacing fuses in underground distribution systems" is one type "of short duration [job] with a possible high hazard arc energy level" (Ex. 0230). However, although the three-phase arc-in-a-box exposures faced by employees working on underground installations may be high, much of the work performed in these locations is on deenergized circuits (269-Ex. 8–5).[370] For the remaining work, which potentially exposes employees to relatively high incident-energy levels, employers will have to choose between providing arc-rated protection appropriate for those levels and reducing the incident-energy level through the installation or work methods changes noted previously. The Agency estimates that, for underground exposures, employers will be able to institute measures, such as increasing working distances, that do not involve substantial expense.

Potential incident-energy exposures for electric power generation installations also can be quite high, but the record shows that employers can implement relatively simple controls to reduce those exposures to levels for which adequately rated protection is readily available. Table 15 summarizes incident-energy estimates for a TVA nuclear generation plant (Ex. 0215).

TABLE 15—DISTRIBUTION OF INCIDENT ENERGY AT TVA GENERATION PLANT

Incident Energy (E) at 455 mm (18 inches), cal/cm²	Number of buses	Percent of buses
0.0 < E ≤ 4.0	26	15
4.0 < E ≤ 8.0	48	29
8.0 < E ≤ 30.0	22	13
30.0 < E ≤ 50.0	32	19
50.0 < E ≤ 75.0	7	4
75.0 < E ≤ 100.0	15	9
100.0 < E ≤ 162.4	18	11

TVA instituted engineering or administrative controls to reduce all incident-energy levels to 100 cal/cm² or less.[371] These controls included:

- Using remote-control voltage test equipment,
- Resetting circuit breaker trip devices,
- Installing current limiting devices,
- Using robotics,
- Employing remote control devices to operate equipment, and
- Developing procedures that increase the working distance between the worker and the arc (*id.*).

Two of these methods, resetting circuit-breaker trip devices and increasing the working distance, do not involve heavy capital outlays. The record identifies other simple methods for reducing incident-energy levels, such as setting up a circuit for work by temporarily adjusting relays (Tr. 940), changing operating procedures to eliminate or minimize the time two sources of power remain tied together (Ex. 0425),[372] and using shields or barriers to block incident energy before it reaches the employee (Ex. 0445). Because they do not make permanent changes to the installation, these methods also do not involve capital expenditures.

The Agency decided to adjust its regulatory analysis to accommodate the extra measures that employers likely will take to reduce incident-energy levels below 100 cal/cm². To account for the costs of adopting incident-energy-control measures for electric power generation installations, OSHA included costs for reducing incident-energy exposures that, when combined with OSHA's estimated costs for calculating incident energy, correspond to TVA's estimate of $300 per employee for firms in industries with generation installations. Because TVA included incident-energy reduction costs in its estimate, OSHA's cost estimates also account for additional engineering controls that employers with power generation installations might need to implement to reduce the incident energy of particular circuits to no more than 100 cal/cm² (the maximum level for which protective clothing and equipment are generally available). In addition, in some cases, employers will be able to institute measures, such as resetting breakers or increasing working distances, that do not involve substantial expense. (See Section VI, Final Economic Analysis and Regulatory Flexibility Analysis, later in this preamble.)

A note following final paragraph (g) explains that Appendix E to final Subpart V contains information on the selection of appropriate protection. This appendix contains information on the ignition threshold of various fabrics, techniques for estimating available heat energy, and means of selecting protective clothing and other protective equipment to protect employees from burn injuries resulting from electric arcs. OSHA adopted this note substantially as proposed, except as necessary to reference the appropriate appendix (Appendix E).

Heat stress. Many commenters argued that arc-rated protection would subject employees to heat-stress hazards. (See, for example, Exs. 0099, 0152, 0169, 0238; Tr. 406, 1105.) Mr. Jean Thrasher with Community Electric Cooperative, for instance, commented:

> An already existing hazard in the utility industry is heat stroke and heat exhaustion. If the calculated arc thermal value results in a requirement for multiple layers of FR clothing, there WILL BE hospitalizations from heat stroke and heat exhaustion. Many manufacturers gloss over or try to hide this concern by claiming they have engineered "cool and comfortable" FR clothing. The simple fact is that in summer, in 90°+ heat with 80% or higher humidity *multiple layers* of any type clothing are too much, especially considering the linemen already are wearing solid rubber from shoulder to fingers on both arms. [Ex. 0152; emphasis included in original]

EEI expressed concern that, in proposing the arc-protection requirements in Subpart V, OSHA did not consider "the impact that excessive clothing could have on employees

[370] Existing § 1910.269(t)(7) already requires protection from hazards posed by energized cables in a manhole. This requirement provides that, where a cable in a manhole has one or more abnormalities that could lead to or be an indication of an impending fault, the defective cable must be deenergized before any employee may work in the manhole, except when service load conditions and a lack of feasible alternatives require that the cable remain energized. In that case, employees may enter the manhole provided they are protected from the possible effects of a failure by shields or other devices that are capable of containing the adverse effects of a fault in the joint.

[371] The highest arc rating for clothing is 100 cal/cm² (Tr. 440).

[372] In a network setting, more than one source can supply a circuit. Diverting one or more of those sources, by switching them so that they do not supply power to that circuit, can reduce the incident-energy level.

working in high temperatures" (Ex. 0227).

There is considerable evidence in the record related to heat-stress hazards. (See, for example, Exs. 0227, 0268, 0363, 0364; Tr. 431–461, 1106–1110.) Record evidence suggests that heat stress can result in:

- Heat cramps (Ex. 0268; Tr. 1106),
- Heat exhaustion (*id.*),
- Heat rash (*id.*),
- Heat stroke (*id.*),
- Fainting (Ex. 0268),
- Loss of concentration (*id.*), and
- Unsafe behaviors (Tr. 1109–1110).

EEI submitted a State of California Finding of Emergency that reported on occupational heat-related illnesses in that State (Ex. 0268). That document reported that "[s]tatistical information from the California Division of Workers Compensation's report on occupational injuries in heat-related illness from 2000–2004 [found] that at least 300 . . . cases of heat-related illness annually [were] recorded by employers or are the subject of claims for Workers Compensation Insurance" (*id.*). EEI noted that heat stress would cause unsafe behaviors, which could lead to accidents involving contact with energized parts, an outcome these commenters contended presents a serious hazard that OSHA should address in the final rule in the context of arc-rated protection (Ex. 0227; Tr. 1109–1110).

OSHA acknowledges that heat stress can pose serious hazards to employees. As EEI noted, OSHA has several documents available that discuss heat-stress hazards and mitigation measures (Ex. 0478). In fact, the Agency has a Web page devoted to this topic (*http://www.osha.gov/SLTC/heatstress/index.html*).

Dr. Thomas Neal explained that "heat stress is an occurrence when the human body core temperature goes over its normal temperature, which we normally state [is] 98.6 degrees F" (Tr. 446). He further described the hazard of heat stress as follows:

> When the work you are doing generates more heat than can escape through your clothing, that heat can only go to your body. So what happens is your body, a fairly sizeable mass that it is, begins to heat up, and if you continue that process for a period of time, your body will basically heat up to a point where you are into a heat stress condition that can be dangerous.
>
> Heat builds up, and the core temperature of your organs and your brain heat up, and just a few degrees above 98.6, and it's been shown that your judgment can be impaired, and the core temperature, if it reaches up to . . . 105, it can actually become a life threatening situation. [Tr. 447]

Dr. James Lancour, testifying for EEI, addressed the factors that can contribute to heat stress:

> Information gleaned from the literature clearly demonstrates the following:
>
> One, heat stress job-risk factors include: hot work environments, the metabolic rate required by the worker to perform the task, the type of protective clothing that is worn by a worker, exposure time, and the age and physical condition of the worker.
>
> Two, as metabolic requirements necessary to perform a given task increase, the exposure time at a given temperature necessary to minimize heat stress decreases.
>
> Three, the amount of clothing worn by a worker tends to increase the risk of heat stress.
>
> Four, as the temperature of the work environment increases above about 30 degrees Centigrade, or 88 degrees Fahrenheit, there is a sharp increase in heat-related illnesses. [Tr. 1108–1109]

The record also clearly shows that electric power generation, transmission, and distribution workers perform tasks outdoors in hot and humid environments. (See, for example, Exs. 0169, 0183, 0220, 0233; Tr. 406, 1003.)

In view of this evidence, OSHA agrees that heat stress poses a significant hazard to employees covered by this final rule. The Agency does not dispute that electric power generation, transmission, and distribution work can be physically demanding and that employees perform this work in hot and humid weather. OSHA also agrees with the testimony of its expert witness, Dr. Mary Capelli-Schellpfeffer, that heat stress "is not a new topic" for employers with employees who perform this type of work and that "strategies to manage thermal hazards, and . . . heat thermal stress, are well appreciated across geographic domains," north and south (Tr. 234–235). Drs. Neal, Lancour, and Capelli-Schellpfeffer noted that employers in this industry must deal with heat-stress hazards even if employees are not wearing arc-rated protection (Tr. 198, 478–479, 1129).

Evidence in the record also indicates that there is a range of measures that employers can take to mitigate heat-stress hazards, including:

- Rest breaks (Ex. 0268; Tr. 198–199),
- Supplying sufficient amounts of water (Ex. 0268; Tr. 199),
- Using cooling vests (Tr. 199),
- Supplying ambient cooling (Tr. 198),
- Providing shade (Ex. 0268), and
- Acclimatizing employees to the heat (Ex. 0268).

Evidence in the record indicates that employers already are using some of these measures (Tr. 1129–1130).

Dr. Neal described the body's metabolic process, which controls how the body responds to heat, as follows:

> If the heat generation from metabolic activity is greater than the heat loss through clothing or through parts of the body, obviously, also that are not clothed, then you have heat stress. Conversely, if the opposite happens, if your heat generation by metabolic activity is less than the heat loss through your clothing and uncovered parts of your body, then you have hypothermia.
>
> So your body operates in a narrow zone, and needs to do that to function effectively. Obviously, both heat stress and hypothermia are dangerous when you move away from that normal zone. . . .
>
> [There are] two main ways the body loses heat, and this comes from a North Carolina State University study of several years ago. One is what we call dry heat transfer, just air moving through my clothing, my body basically giving up heat as that happens. If I am cold, that is what is happening or, if I am in a comfort zone, that's pretty much what is happening.
>
> If I get hotter, then I begin to perspire and go into the evaporative heat transfer process, which is a very effective way of losing heat. . . . So then I am in a discomfort zone . . . . Finally, if I get to the point where I can't los[e] enough heat by sweating and by dry heat transfer to maintain my body temperature, I go into a heat stress situation where my core temperature begins to rise. [Tr. 448–449]

Dr. Neal then described how arc-rated clothing affects this process:

> Flame resistant shirts, pants, coveralls that you wear are basically like any other clothing article. They are breathable. We actually measure that in terms of air permeability, and they are typically lighter weight or similar weight than conventional cotton work apparel like jeans or cotton shirts that would be worn as nonmeltable work clothing.
>
> So they don't really function any different when you are wearing them. You may feel different. Again, somebody tells me it's not as comfortable as his cotton shirt, I'm not going to argue that, because he has to be the judge of what is comfortable. But it is not anymore prone to heat stress is my point on that.
>
> . . . The heat stress potential for the wearer [of] FR clothing would be typically less than or equivalent [to] typical conventional work clothing. . . . I'm talking about regular shirts, pants, and coveralls that you would wear for protection, and it would give you something up to maybe 8 calories or so of protection, single layer-wise.
>
> * * * * *
>
> When arc flash suits basically have higher ratings like 25 or 40 calories, 100 calories, 60 calories—there are many different levels that are fairly high—well, there are multiple layers that are used to create those levels of protection. So heat, obviously—and there are hoods involved in those. So in those cases, obviously, the heat stress potential does go up. [Tr. 449–451]

Dr. Neal presented two tables, one showing metabolic rates for different

tasks and the other showing heat-loss values for various types of protection (Ex. 0363). OSHA is reproducing these tables here as Table 16 and Table 17, respectively.

TABLE 16—METABOLIC RATES FOR VARIOUS TASKS

Task	Metabolic rate (W/m^2)
Standing	70
Walking at 1.3 m/s (4.4 ft/s)	180
Tennis	260
Heavy labor	320–440
Wrestling	500

TABLE 17—TYPICAL HEAT LOSS VALUES THROUGH CLOTHING

Clothing material	Total heat loss (W/m^2)
205-gm/m^2 (6-oz/yd) Meta-aramid FR Woven Fabric (for example, NOMEX)	747.
205-gm/m^2 (6-oz/yd) Cotton T-shirt Knit	688.
Lightest 8-cal/cm^2 FR Shirt-Pants Fabric	500 to 600.
40-cal/cm^2 systems	300 to 400.
Firefighter turnout, breathable	150 to 250.
100-cal/cm^2 arc-flash suits	150 to 250.
Firefighter turnout, nonbreathable	80 to 120.

OSHA presumes that electric power work is equivalent to heavy labor, with a metabolic rate of 320 to 440 watts/meter^2. As demonstrated in Table 17, even 8-cal/cm^2 clothing does not interfere with heat loss significantly more than normal (non-flame-resistant) work clothing. Thus, the Agency concludes that employers can treat clothing with an arc rating of 8 cal/cm^2 or less the same as normal work clothing with respect to its contribution to heat stress and that clothing with an arc rating of 8 cal/cm^2 or less should not require any significant changes to measures employers already are taking to protect electric power workers from heat stress generally (Tr. 503—504).

Employers with employees who are in protection with arc ratings between 8 and 25 cal/cm^2 will need to start planning for, and implement, heat-stress mitigation strategies beyond the strategies used for employees wearing normal work clothing (*id.*). These employers may need to choose among such mitigation strategies as: Providing the lightest-weight arc-rated clothing for the estimated incident-energy level, ensuring that employees take extra rest breaks, and reducing the incident energy using the methods described previously. However, employers will need to take these measures only when the ambient temperature warrants such actions.

As shown in Table 16 and Table 17, when the estimated energy level rises above 25 cal/cm^2, employers likely will need to implement a variety of heat-stress reduction measures, except for short-duration tasks. An employee who is performing heavy labor has a metabolic rate of 320 to 440 watts/m^2 (Table 16). Protection rated at 40 cal/cm^2 provides for a heat loss of 300 to 400 watts/m^2 (Table 17). However, tasks requiring this level of protection [373] are normally of short duration (Tr. 202). Such tasks include racking circuit breakers (Tr. 381), replacing fuses in an underground installation (Ex. 0230), and removing or installing socket-type meters (*id.*). Dr. Capelli-Schellpfeffer also testified that, even when employees are wearing this level of protection, "at one to two minutes, three minutes, four minutes, in that ballpark, [it] is very, very uncommon to appreciate that there would be any thermal challenge significant enough to take . . . an employee to a heat stress condition" (Tr. 202—203). Dow Chemical Company similarly commented that arc-rated clothing "is only needed when an employee is working where there is a substantial potential for an arc flash, which typically should be for very short periods of time" (Ex. 0128).[374]

Mr. Wilson Yancey with Quanta Services maintained that "[o]n transmission work, employees often experience potential fault currents that would require multiple layers of FR clothing, plus a 40 calorie space suit with hood and shield, to provide the necessary protection" (Ex. 0169). In addition, EEI presented information contending that clothing rated for more than 100 cal/cm^2 might be necessary when employees work on 15-kilovolt distribution circuits with varying fault current levels (Ex. 0227). However, OSHA concludes that neither of these cases represents typical exposures for distribution or transmission systems. As explained earlier, under the summary and explanation for paragraph (g)(2) of the final rule, the NFPA 70E Annex D calculation method EEI used to arrive at its 97- to 153-cal/cm^2 estimates is extremely conservative and likely would produce extremely elevated estimates at voltages of more than 15 kilovolts. EEI's corresponding estimate, based on Table 8 in proposed Appendix F, was only 5 cal/cm^2 (*id.*), which, as explained earlier, would not require employers to put employees in protection that would cause concerns about heat stress. There is no evidence in the record that fault currents on transmission circuits typically are higher than the fault currents listed in Table 7 of final Appendix E or that incident-energy estimates likely would be higher than the values in that table.

As explained under the heading *Other issues relating to the selection of protective clothing and other protective equipment,* earlier in this section of the preamble, the Agency concluded that most exposures on overhead transmission and distribution systems, where employees perform much of the work covered by the final rule, are no higher than 12 cal/cm^2. Furthermore, as noted by Dr. Capelli-Schellpfeffer, the types of tasks that require protection rated at more than 25 cal/cm^2 are typically of short duration and will not require measures to reduce heat stress (Tr. 202–203). Thus, the final rule will not result in employers having to take

[373] Dr. Capelli-Schellpfeffer described this level of protection as "fully enclosing FR protective clothing," which includes a protective hood (Tr. 202). Dr. Neal testified that a faceshield attached to a hard hat and a balaclava could be used in lieu of a hood for exposures up to about 40 cal/cm^2 (Tr. 439).

[374] OSHA interprets this comment as applying to tasks performed in a generation plant or substation, as the Agency does not believe that Dow Chemical performs maintenance on utility-type transmission or distribution installations.

additional measures to protect workers from heat stress in most cases. When incident energy requires protection rated at more than 8 cal/cm², but no more than 12 cal/cm² (the highest level in Table 6 and Table 7 in final Appendix E), employers might have to take some additional measures to protect employees in elevated ambient temperatures from heat stress. (See, for example, Tr. 503–504.) Even under these conditions, the Agency concludes that these measures should not be extreme because the clothing weight should be only slightly higher than 8-cal/cm² clothing,[375] and because affected employers already institute measures under these conditions to mitigate heat-stress hazards (Tr. 197–198, 1129–1130).

Heat stress is a widely recognized hazard, and employers covered by the final rule already have an obligation under the general duty clause of the OSH Act to abate these hazards.[376] As noted earlier, the record indicates that employers covered by the final rule already are addressing heat-stress issues in their workplaces. Depending on the level of protection afforded to comply with final paragraph (g)(5), employers may have to adjust their heat-stress programs, but the Agency believes that employers will be able to provide compliant protection under paragraph (g)(5) without necessarily exposing employees to dangerous heat-stress conditions. Moreover, OSHA believes that EEI's concerns about heat stress from arc-rated protection causing unsafe acts are groundless even if the protection could increase heat stress experienced by employees, because employers can take measures to abate the heat-stress hazard.

In summary, the Agency agrees with IBEW's posthearing brief on the subject of heat stress:

> Another issue raised during the hearing was the specter that wearing FR clothing increases the risk of heat stress for employees working in hot climates. While the record is replete with reference to heat stress, material about its attendant hazards, and advice about how to avoid it, see, e.g., Ex. [0478] (EEI Post-Hearing Comments; references to materials on OSHA's Web site), there is absolutely no evidence in the record that employees wearing FR clothing are necessarily at greater risk of suffering heat stress than employees working in similar conditions but wearing regular work clothes.
>
> Heat stress is a function of a number of different factors, including not only the kind of clothing the employee is wearing, but the heat load of the particular operation in which the employee is involved, the level of exertion associated with the employee's tasks, his or her physical condition and diet, and such environmental conditions as temperature and humidity. [Tr.] 198, 234[,] 1349–51; Ex. [0363]. Dr. Capelli-Schellpfeffer explained that the extent to which clothing poses a heat stress problem is less a function of the FR rating than the degree to which it encloses the body and prevents it from cooling. Thus, for most FR clothing worn during routine operations, if the clothing is not "enclosing" and the body has the ability to cool naturally, its FR nature will not pose any more of a heat stress threat than any other clothing. [Tr.] 200–01, 249. Thomas Neal, of Neal Associates, added that although heavier clothing may contribute to heat stress, the availability of lighter weight FR clothing is minimizing that issue. Ex. [0363]. And representatives of both the utility industry ([Tr.] 388 (ElectriCities)) and electrical contractors ([Tr.] 1349, 1350, 1351) concurred that although they certainly have had experience with heat stress, they were unaware of any situation that would not have occurred if the employee had not been wearing FR clothing. In fact, Quanta's Wilson Yancey noted that of the 6000 company employees who worked during last summer's extreme hurricane season, there was not one case of heat stress that he would attribute to FR clothing. [Tr.] 1350.
>
> This is not to disregard the fact that heat stress is an issue for electrical transmission and distribution workers—whether or not they are wearing FR clothing. The record shows, however, that there are industrial hygiene strategies for minimizing the possibility that employees working in hot, humid conditions experience heat stress, which utility and contractor employers either do or should utilize. These strategies include controlling the amount of time a particular employee performs a particular task, rotating employees, permitting cooling rests, ensuring adequate fluid intake, and utilizing light-weight, layered systems of arc-rated clothing. [Tr.] 198–99[,] 460; Ex. [0363].
>
> Where the arc hazard analysis dictates putting employees in such highly rated FR clothing that heat stress or other performance impediments become a real problem, the answer may be to employ other strategies for protecting the employee from the threat. For example, an arc hazard analysis showed Gallatin Steel that it needed to develop alternative switching procedures to minimize employee exposure to arc flashes. Ex. [0460]. NIOSH recommends establishing "flash protection boundaries" from which employees can maintain a sufficient distance from the exposure that they will not require protective clothing. Ex. [0130]. See also [Tr.] 498–99 (examples from other industries that have employed methods to lower heat energy estimates). [Ex. 0505]

Are FR and arc-rated clothing personal protective equipment? As described earlier, OSHA is requiring employers, in certain situations, to ensure that their employees (1) wear flame-resistant clothing and (2) wear protective clothing and other protective equipment with an arc rating greater than or equal to the heat energy estimated under paragraph (g)(2) of the final rule. In the preamble to the proposal, OSHA stated that it considered the protective clothing required by proposed paragraph (g) to be PPE (70 FR 34868). As the preamble noted, the protective clothing would reduce the degree of injury sustained by an employee when an electric arc occurs and, in some cases, would prevent injury altogether (*id.*).

Many rulemaking participants objected to OSHA's classification of arc-rated clothing as PPE. (See, for example, Exs. 0125, 0157, 0170, 0172, 0185, 0207, 0209, 0504, 0506; Tr. 544–547, 1123–1124.) For instance, Mr. Jonathan Glazier with NRECA commented:

> To avoid any confusion, NRECA requests that OSHA reiterate its longstanding position that FR clothing is not PPE. That is, FR clothing, when it is not used as protective clothing, is not PPE even though it also has a protective value. For an example of OSHA's longstanding position on FR clothing as not being PPE, see the statement in the July 31, 1995 letter from John B. Miles, Jr., Director, Directorate of Compliance Programs, to Mr. Jack Callaway, Director of Environment Affairs, Sho-Me Power Electric Cooperative, that the Power Generation, Transmission, and Distribution standard section "1910.269 (l)(6)(iii) is not a personal protective (clothing) equipment requirement." [Ex. 0233]

The letter of interpretation referred to by Mr. Glazier simply states that existing § 1910.269(l)(6)(iii), which prohibits the use of clothing that could increase the extent of an injury in the event of an arc exposure, is not a *requirement* for PPE. The letter does not state that FR clothing itself is not PPE. An OSHA memorandum to the field describes this Agency policy more explicitly:

> The Apparel Standard is intended to provide worker protection from exposure to the secondary hazard of the employee's clothing burning or melting and making even worse any injuries caused by primary exposure to the electric arc or flame. While OSHA requires, with exceptions, that employers provide and pay for PPE, paragraph 1910.269(l)(6)(iii) is silent on these points. Note that this Apparel Standard is not considered a personal protective equipment (PPE) *standard;* however, it may apply to personal protective equipment. [Emphasis added.] For example, paragraph 1910.269(l)(6)(iii) applies to an employer who provides personal protective clothing worn by an employee, who is exposed to the hazards of electric arcs or flames, for protection against cold or rain.

Because it is not a PPE requirement, the Apparel Standard does not address whether

[375] Clothing rated 15 to 20 cal/cm² is available in weights of 300 gm/m² (8.8 oz/yd²), less than typical jeans-weight material (370 gm/m², or 11 oz/yd²) (Ex. 0363).

[376] See, for example, *http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=24008.*

or not an employee's clothing must cover all exposed parts of the employee's body. The Apparel Standard, by itself, does not prohibit employers from purchasing flame-retardant-treated short sleeve shirts or from altering flame-retardant-treated long sleeve shirts to shorten the sleeves. However, such practices are discouraged. Flame-retardant-treated clothing provides a measure of protection to an employee exposed to an electric arc.

From this standpoint, flame-retardant-treated clothing which covers not only the body and legs, but also the arms provides better protection to the employee.

Note: An employer would be in a citable posture for violation of [§ 1910.132] of the Subpart I *Personal protective equipment* standard when it is a generally accepted safe work practice of the industry to wear clothing which covers the arms, legs or other exposed surfaces of the body to protect an employee in a particular workplace application and the employee does not do so. [Memorandum for: Regional Administrators, From: James W. Stanley, dated August 10, 1995, Subject: Guidelines for the Enforcement of the Apparel Standard, 29 CFR 1910.269(l)(6), of the Electric Power Generation, Transmission, and Distribution Standard; [377] emphasis included in original]

This memorandum makes it clear that, while OSHA does not treat existing § 1910.269(l)(6)(iii) as a PPE requirement, some FR clothing may be PPE for purposes of other OSHA standards.

Some rulemaking participants maintained that OSHA did not define PPE or argued that the Agency was defining PPE to include FR clothing for the first time in this rulemaking. (See, for example, Exs. 0207, 0222, 0233; Tr. 568.) For instance, the Small Business Administration's Office of Advocacy commented: "OSHA declares in a single sentence in the preamble that it now views protective clothing as PPE, a position that OSHA has previously not asserted" (Ex. 0207; footnote omitted). Mr. Chris Tampio with NAM argued:

The basic Personal Protective Equipment (PPE) standards for general industry and construction are found in Sections 1910.132 and 1926.95, respectively, and have been in existence for over 30 years. To the best of our knowledge, these provisions have not been interpreted to require fire-resistant or arc-rated clothing to address arc flash hazards. If OSHA already interpreted Section 1910.132 or 1926.95 to require fire-resistant or arc-rated clothing to address arc flash hazards, there would have been no reason to propose the clothing requirements in the current rulemaking. Accordingly, should the final rule contain provisions requiring arc flash hazard assessments and FR/AR clothing, it is essential for OSHA to insert language into the final rule and the preamble to the final rule clarifying that the agency's interpretations of Sections 1910.132 and 1926.95 remains unchanged—that they do not require flame-resistant and arc-rated clothing in connection with any arc flash hazards that may exist outside the activities covered by Section 1910.269 and Subpart V.

* * * * *

OSHA's discussion of the clothing requirements in the preamble to this rulemaking demonstrate that fire-resistant clothing is . . . not considered PPE under Section 1910.132:

OSHA's existing clothing requirement in § 1910.269 [which incorporates the personal protective equipment requirements of Subpart I of Part 1910 by reference into Section 1910.269(g)(1)] does not require employers to protect employees from electric arcs through the use of flame-resistant clothing. It simply requires that an employee's clothing do no greater harm. Because of the serious nature of the still remaining risk to power workers from electric arcs, the Agency believes that the standard should be revised to require the use of flame-resistant clothing, under certain circumstances, to protect employees from the most severe burns.

Section 1910.132, "General Requirements [for PPE]", is OSHA's general PPE standard which requires that PPE shall be used wherever necessary by reason of workplace hazards. Because 1910.269 already incorporates § 1910.132, there would be no reason to revise § 1910.269 (or Subpart V) to require the use of FR/AR clothing, or to perform an economic impact analysis of the additional burden of that requirement, if FR/AR clothing was already required by § 1910.132 (or § [1926].95) to address the arc flash hazard.

. . . In [a] 1999 rulemaking, OSHA issued [a notice of proposed rulemaking] to address the issue of whether an employer would be required to pay for the PPE required by § 1910.132. The scope of that preamble and the technical and economic feasibility analysis for that proposal were limited to head, eye, hand, face and foot protection, and some forms of protective clothing (other than arc-rated or fire-resistant clothing). There was no mention of its application to fire-resistant or arc-rated clothing for electrical workers. The NAM respectfully submits that, to this day, as the subject rulemaking acknowledges, OSHA has never interpreted § 1910.132 or 1926.95 to require fire-resistant clothing or arc-rated clothing to address arc flash hazards.

In light of this well-established interpretation of §§ 1910.132 and 1926.95, we respectfully submit it may not be materially changed except through notice and comment rulemaking that clearly announces to all interested parties that such an enormous change is under consideration. It is well-established that agency interpretations, even when reasonable constructions of its rules, trigger notice and comment requirements under the APA when the interpretation represents a significant change from a previous, definitive interpretation. *See Alaska Professional Hunters Association, Inc.* v. *FAA*, 177 F.3d 1030, 1034 (D.C. Cir. 1999). [Ex. 0222; footnotes omitted; emphasis included in original.]

First, the Agency considers irrelevant the argument that, if §§ 1910.132 and 1926.95 already cover arc-rated clothing, OSHA does not need separate requirements for such clothing in Subpart V and § 1910.269. The regulated community could construe existing § 1910.269(l)(6)(iii), because it explicitly covers electric-arc hazards for work performed under § 1910.269, to preempt application of § 1910.132(a) to electric-arc hazards in electric power generation, transmission, and distribution work. Consequently, OSHA needed to revise § 1910.269, as it proposed to do, to clarify that employees must use arc-rated clothing for work covered by that standard.

Second, the commenters' statements about current OSHA policy are wrong. The Agency currently considers FR clothing to be PPE; OSHA is not establishing new policy on that issue in this final rule. The Agency has issued, and the Occupational Safety and Health Review Commission has upheld, citations against employers for violating § 1910.132(a) by not providing flame-resistant clothing to employees. (See, for example, *Lukens Steel Co.*, 10 BNA OSHC 1115 (No. 76–1053, 1981) (Section 1910.132 required the use of "protective equipment, including . . . flame retardant clothing" for employees exposed to burn hazards at a steel-producing facility).) In addition, the Agency has issued several letters of interpretation stating that, under certain circumstances, § 1910.132(a) or § 1926.95(a) require FR clothing. (See, for example, letters of interpretation dated March 7, 2006, to Mr. Joseph P. Zemen [378] (FR clothing in plants processing flammable materials) and February 29, 2008, to Mr. Brian Dolin [379] (protection against arc-flash hazards for work covered by 29 CFR Part 1926, Subpart K).)

In the recently completed rulemaking on employer payment for personal protective equipment (72 FR 64342), some commenters suggested "that FR clothing is not PPE." (72 FR 64353). OSHA rejected that argument, noting:

If OSHA determines in [the Subpart V] rulemaking that FR clothing is required, it will then become subject to the PPE payment provisions of this rule . . . [*Id.*]

Thus, it is clear that the Agency considers flame-resistant clothing to be PPE. In this regard, this rulemaking does not establish new policy or revise

[377] The full text of this memorandum is available at *http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=21878.*

[378] This letter is available at *http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=25366.*

[379] This letter is available at *http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=25973.*

longstanding policy, as the commenters suggested.[380]

Consistent with past policy, OSHA believes that it is reasonable and appropriate to treat FR and arc-rated clothing required under final paragraph (g) as PPE. FR clothing required by paragraph (g)(4) of the final rule will protect against the ignition of clothing, and arc-rated clothing, as required by paragraph (g)(5) of the final rule, will protect against heat-related hazards caused by electric arcs. Dr. Mary Capelli-Schellpfeffer explained that electric arcs can "occur unintentionally in man-made systems" and represent "a common electrical fault condition which may lead to a failure in the power system" (Ex. 0373). She explained that, when an employee is repairing an electrical installation, "[i]f the installation remains energized, or is not in an electrically safe working condition, the risk of electric arc persists, and may be increased as a result of the post-fault status" (*id.*). As Dr. Capelli-Schellpfeffer noted, the causes of electric arcs include: transient overvoltage disturbances, such as lightning and switching surges; mechanical damage from foreign sources, such as digging or vehicles; shorting by tools or metal objects; mechanical failure of static or structural parts; and insulation breakdown (*id.*). Thus, electric arcs commonly result from the breakdown of equipment in the process of generating, transporting, or using electricity or from the process of repairing an electrical installation.

Dr. Capelli-Schellpfeffer also described the thermal hazards posed by electric arcs, explaining:

> With temperatures rising in and around an arc, burn hazard is present from ohmic heating due to electrical power flow; ignition and combustion of nearby materials, notably including worn clothing and adjacent equipment; and sprayed or blown hot or melting installation elements moved by the mechanical forces in the electric arc event. Additionally, radiation is another major source of heat. [Ex. 0373; see, also, Tr. 178–188.]

Thus, thermal hazards posed by electric arcs arise not only from the processes but are a direct result of the rapidly changing environment that results from a fault in an electrical system.

Dr. Capelli-Schellpfeffer also described the injuries that can result from electric arcs:

> The injuries that accompany high temperature exposures at the body surfaces are commonly referred to as skin burns. When these injuries are distributed within the body we still call them skin burns, and the burn generally refers to a physical chemical change.
>
> As many appreciate from the experience of sunburn, this kind of condition is painful, and when the trauma is more severe, the pain is extraordinary, and of course the medical treatment is extensive. [Tr. 188]

As noted earlier, she graphically depicted these injuries with a photograph of the victim of an electric arc, which she explained as follows:

> [T]he extent of the injury that can follow an arc exposure is readily appreciated. Eyes, ears, faces, skin, limbs, and organs are affected. Basic bodily function, including the ability to breathe, eat, urinate, and sleep are completely changed. [Tr. 186]

Thus, thermal injuries from an electric arc occur when an employee's body absorbs the heat from the arc.

In light of the foregoing discussion, OSHA concludes that FR clothing and arc-rated clothing will protect against "hazards of processes or environment" and are designed to protect against hazards "encountered in a manner capable of causing injury or impairment in the function of any part of the body through absorption, inhalation or physical contact." Thus, OSHA is reiterating that FR clothing and arc-rated clothing are PPE as §§ 1910.132(a) and 1926.95(a) generally describe that term.

Mr. Jonathan Glazier with NRECA argued that FR clothing is not protective (Ex. 0506; Tr. 544–545). At the hearing, Mr. Glazier testified:

> The FR nature of clothing offers no protective value. It refers merely to the clothing's inability to melt or ignite and remain ignited. We should be aware of the difference between the attribute of FR and the attribute of protection.
>
> It gets confusing, because arc protective clothing, which sounds like it may be personal protective equipment, and OSHA says it is personal protective equipment in the preamble . . .
>
> It gets confusing, because arc protective clothing is first FR. That is, all arc protective clothing is also FR, and I am told that all FR clothing sold nowadays has an arc protective rating.[381] But still, there is a difference between the FR attribute and the arc protective attribute. [Tr. 544–545]

OSHA disagrees with Mr. Glazier. FR clothing, even without an arc rating, protects employees against burns caused by radiant and convective heat as well as burns caused by potential ignition of clothing that is not flame resistant. Dr. Thomas Neal testified that FR clothing "not only [does not] ignite and, basically, eliminate[s] the burning clothing on the body syndrome, but [it] also provide[s] a level of protection by blocking heat from reaching the body" (Tr. 472). Dr. Capelli-Schellpfeffer similarly testified that "FR clothing . . . is protective and designed to resist ignition and block heat transfer" (Tr. 189). An arc-rating on FR clothing is a measure of how much incident energy can be present before the wearer will just barely sustain a second-degree burn (Ex. 0061). Clearly, arc-rated clothing and FR clothing (even without an arc rating) protect employees from being burned by electric arcs and are, therefore, protective.

Mr. Frank White with ORC Worldwide expressed concern that OSHA would consider untreated cotton clothing to be PPE (Ex. 0235). He noted that Table 10 in proposed Appendix F listed untreated cotton clothing as "protective" for incident energy up to 2 cal/cm^2 and that "at higher incident energy exposures a [T]-shirt is listed as the first layer of protective clothing, followed by other layers of FR clothing" (*id.*). Mr. White also interpreted Table 11 from proposed Appendix F, which listed ignition thresholds for various weights of cotton fabrics, as indicating that these fabrics provide "protection from heat energy below the ignition threshold" (*id.*).

Untreated cotton can ignite and continue to burn when subjected to incident heat energy above its ignition threshold (Tr. 467–469, 472). OSHA does not consider cotton clothing, which can ignite and pose a hazard itself, as constituting protective clothing with respect to electric arcs common to work covered by the final rule. Therefore, OSHA did not include Table 10 or Table 11 from proposed Appendix F in final Appendix E. (See also the summary and explanation for the appendices to Subpart V, later in this section of the preamble.) Finally, even though wearing cotton clothing as one

[380] Mr. Tampio also argued that FR clothing is not considered electrical protective equipment under § 1910.335 (Ex. 0222). This argument is not relevant to this discussion. However, note that OSHA agrees with Mr. Tampio that FR clothing is not electrical protective equipment. This equipment, covered by §§ 1910.137 and 1926.97 in this final rule, protects employees from electric shock. FR clothing, whether arc-rated or not, does not provide protection against electric shock.

In addition, Mr. Tampio argued that the hazard assessment and training requirements in § 1910.132 apply only to head, eye, hand, face, and foot protection. OSHA also agrees with this statement, but again finds it irrelevant. The limitation of the PPE hazard assessment and training provisions, contained in § 1910.132(g), has no bearing or effect on the types of PPE covered by the general requirement to provide PPE in § 1910.132(a). The preamble to the Subpart V proposal requested comment on whether to extend the hazard assessment and training requirements of § 1910.132 to electrical protective equipment, which is another form of PPE covered by § 1910.132(a) (70 FR 34893).

[381] OSHA is aware that some FR clothing, such as children's FR sleepwear and certain types of FR clothing made specifically for protection from contact with molten metal, are not arc rated.

layer in a clothing system can effectively increase the arc-rating of the system, OSHA does not consider cotton clothing to be protective.[382]

Some commenters maintained that OSHA needed to conduct a separate rulemaking to determine whether FR clothing is PPE. (See, for example, Exs. 0170, 0183, 0202, 0207, 0222, 0229, 0233, 0239, 0240.) For instance, Mr. Alan Blackmon with Blue Ridge Electric Cooperative commented that, if "OSHA institutes an arc protective clothing requirement, its nature as PPE or non-PPE should be the subject of public notice and comment. It is not enough for OSHA merely to issue a pronouncement in the Preamble of this rulemaking" (Ex. 0183).

The U.S. SBA's Office of Advocacy suggested that "the issue of protective clothing as PPE [was] not . . . fully vetted in the rulemaking process" and recommended that "OSHA address the issues of protective clothing, PPE, and employer payment for PPE in the PPE rulemaking process and not finalize these provisions prior to that rulemaking's conclusion" (Ex. 0207).

As noted earlier, existing OSHA policy treats FR clothing (whether or not it is arc rated) as PPE. OSHA's statement in the preamble to the proposed rule simply reaffirmed that position. Although the Agency does not believe notice and comment is necessary on this issue (see, for example, 5 U.S.C. 553(b) (APA notice and comment requirements do not apply "to interpretative rules")), affected parties had clear notice in the preamble to this rulemaking that the Agency was considering whether employers would have to pay for the arc-rated clothing required by the final rule (an issue discussed later in this section of the preamble). OSHA believes that the public also had clear notice that the Agency considered FR clothing to be PPE and had ample opportunity to challenge the Agency on that point as it relates to this rulemaking. Consequently, OSHA concludes that there is no need to conduct further rulemaking related to the issue of whether FR clothing is PPE.

Who should pay for the PPE required by paragraph (g) of the final rule? As explained earlier, OSHA considers FR clothing and arc-rated clothing required by the final rule to be PPE. The proposed rule did not specify whether employers would have to provide protective clothing at no cost to employees. However, OSHA noted in the preamble to the proposal that it was considering including an employer-payment requirement in the final rule and sought comments on the issue.

The preamble to the proposal also noted that OSHA had proposed regulatory language for the general PPE standards to clarify that employers generally are responsible for the cost of PPE (70 FR 34869, citing 64 FR 15402, Mar. 31, 1999). OSHA published the final rule on employer payment for PPE on November 15, 2007 (72 FR 64342). The final rule on employer payment for PPE requires employers to pay for the PPE used to comply with OSHA standards, with a few exceptions, including (1) everyday clothing, such as longsleeve shirts, long pants, street shoes, and normal work boots; and (2) ordinary clothing, skin creams, or other items, used solely for protection from weather, such as winter coats, jackets, gloves, parkas, rubber boots, hats, raincoats, ordinary sunglasses, and sunscreen. (See 29 CFR 1910.132(h); 29 CFR 1926.95(d).)

In the PPE-payment rulemaking, OSHA explained the rationale behind its decision to require employers generally to pay for PPE, as follows:

1. The OSH Act Requires Employer Payment for PPE

OSHA is requiring employers to pay for PPE used to comply with OSHA standards in order to effectuate the underlying cost allocation scheme in the OSH Act. The OSH Act requires employers to pay for the means necessary to create a safe and healthful work environment. Congress placed this obligation squarely on employers, believing such costs to be appropriate in order to protect the health and safety of employees. This final rule does no more than clarify that under the OSH Act employers are responsible for providing at no cost to their employees the PPE required by OSHA standards to protect employees from workplace injury and death.

* * * * *

2. The Rule Will Result in Safety Benefits

Separate from effectuating the statutory cost allocation scheme, this rule will also help prevent injuries and illnesses. OSHA has carefully reviewed the rulemaking record and finds that requiring employers to pay for PPE will result in significant safety benefits. As such, it is a legitimate exercise of OSHA's statutory authority to promulgate these ancillary provisions in its standards to reduce the risk of injury and death.

There are three main reasons why the final rule will result in safety benefits:

- When employees are required to pay for their own PPE, many are likely to avoid PPE costs and thus fail to provide themselves with adequate protection. OSHA also believes that employees will be more inclined to use PPE if it is provided to them at no cost.
- Employer payment for PPE will clearly shift overall responsibility for PPE to employers. When employers take full responsibility for providing PPE to their employees and paying for it, they are more likely to make sure that the PPE is correct for the job, that it is in good condition, and that the employee is protected.
- An employer payment rule will encourage employees to participate wholeheartedly in an employer's safety and health program and employer payment for PPE will improve the safety culture at the worksite.

* * * * *

3. Clarity in PPE Payment Policy

Another benefit of the final PPE payment rule is clarity in OSHA's policy. While it is true that most employers pay for most PPE most of the time, the practices for providing PPE are quite diverse. Many employers pay for some items and not for others, either as a matter of collective bargaining or long standing tradition. In some cases, costs are shared between employees and employers. In other workplaces, the employer pays for more expensive or technologically advanced PPE while requiring employees to pay for more common items. However, in some workplaces exactly the opposite is true. [72 FR 64344]

OSHA concludes that there is no evidence in the Subpart V rulemaking record to persuade the Agency that any of these reasons are invalid with respect to FR and arc-rated clothing. As explained later, OSHA considered and rejected nearly all of the arguments against an employer-payment requirement for FR and arc-rated clothing in the PPE-payment rulemaking. As noted previously, OSHA specifically considered FR clothing in the PPE-payment rulemaking and concluded in the preamble to the final PPE-payment rule that, "[i]f OSHA determines in [the Subpart V] rulemaking that FR clothing is required, it will then become subject to the PPE payment provisions of this rule, unless the final § 1910.269 and Part 1926 Subpart V standards specifically exempt FR clothing from employer payment" (72 FR 64353). Therefore, the default position for the Subpart V rulemaking is that employers must pay for the FR and arc-rated clothing required by this final rule unless the Agency adopts provisions specifically exempting this clothing from the general PPE-payment rule. Also, for reasons described later, OSHA concludes that such an exemption is neither necessary nor appropriate for the FR or arc-rated clothing required under paragraph (g) of this final rule. The general PPE-payment rule, including all exceptions, applies to the FR and arc-rated clothing used to comply with this final rule. (See 72 FR 64369.)

Several rulemaking participants supported requiring employers to pay for the FR clothing and arc-rated clothing required by the final rule. (See, for example, Exs. 0130, 0164, 0197, 0211, 0230, 0505; Tr. 819–820, 834, 897–898.) These rulemaking participants gave several reasons for supporting an employer-payment requirement:

- Many employers already are providing this protective clothing (Exs. 0230, 0505; Tr. 897–898),
- Employers are more likely to properly train employees in using PPE (Ex. 0211),

[382] Note that, even if cotton clothing in these circumstances were PPE, §§ 1910.132(h)(4)(ii) and 1926.95(d)(4)(i) exempt "everyday clothing" from the employer-payment requirements in §§ 1910.132(h) and 1926.95(d).

- Employers are more likely to select, and ensure that employees wear, proper protective clothing (Exs. 0197, 0211, 0230),
- Employers are more likely to properly maintain the protective clothing (Exs. 0130, 0211, 0230), and
- The OSH Act requires employers to pay for this type of protection (Tr. 848—849).

Other commenters opposed an employer-payment requirement. (See, for example, Exs. 0099, 0125, 0146, 0169, 0173, 0186, 0201, 0209, 0222; Tr. 546—547.) These rulemaking participants presented the following reasons for not imposing such a requirement:

- The difficulty and expense contractors would have buying protective clothing for employees who move from employer to employer (Exs. 0169, 0186),
- Employees take better care of clothing when they pay at least a portion of the cost (Exs. 0099, 0186),
- Employers consider protective clothing a "tool of the trade" that employees must bring with them to the job (Ex. 0222; Tr. 295–297),
- FR and arc-rated clothing only provides secondary protection (Exs. 0209, 0210), and
- Protective clothing is personal because employees can wear it off the job (Exs. 0125, 0146, 0173, 0209, 0222).

OSHA examined several of these arguments in the PPE-payment rulemaking. For example, the Agency explained how employers could handle the problems associated with transient workforces:

> If the employer retains ownership of the PPE, then the employer may require the employee to return the PPE upon termination of employment. If the employee does not return the employer's equipment, nothing in the final rule prevents the employer from requiring the employee to pay for it or take reasonable steps to retrieve the PPE, in a manner that does not conflict with federal, state or local laws concerning such actions. In these situations, OSHA notes that the employer is not allowed to charge the employee for wear and tear to the equipment that is related to the work performed or workplace conditions. As suggested by National Tank Truck Carriers, Inc., a written agreement, for example, between the employer and employee on the matter may be an effective method of ensuring that the employer's expectations of the employee are clear and unambiguous . . . . Another acceptable alternative is a deposit system that provides an incentive for employees to return the equipment. However, the Agency cautions that the deposit system must not be administered in a fashion that circumvents the rule and results in an employee involuntarily paying for his or her PPE.
>
> In some situations, an employer may prohibit an employee from using PPE that the employer has paid for while working for another employer. . . . Conversely, an employer may allow an employee to use employer-owned PPE while working for another employer. . . . Since the employer has retained ownership of the PPE, he or she can stipulate where it is used. OSHA does not object to either of the aforementioned practices. [72 FR 64359]

The same solutions apply here. OSHA notes that the record in this rulemaking describes another possible solution for contractors employing unionized labor. Mr. Jules Weaver with Western Line Constructors Chapter testified that "[t]here are certain parts of the country in our industry, IBEW and [NECA], have a . . . safety fund, and the contractors pay into it, and they provide FR clothing for individuals" (Tr. 307). Thus, although providing employees with PPE, including FR clothing and arc-rated clothing, might be challenging for employers with transient workforces, the Agency believes that there are reasonable compliance options available.

In the PPE-payment rulemaking, the Agency rejected an argument that employees take better care of PPE than employers, explaining: "OSHA is also not swayed by [the] arguments that employees are in a better position to maintain, use, and store PPE. In fact, the existing PPE standards place on employers the responsibility for ensuring proper fit, use, and maintenance of PPE" (72 FR 64380). The same rationale applies to the argument in this rulemaking that employees take better care of protective clothing when they pay for all, or a portion, of it. The OSH Act and the PPE standards at §§ 1910.132 and 1926.95 make the employer, not the employee, responsible for the care and maintenance of PPE.

In the PPE-payment rulemaking, the Agency decided not to exempt "tools of the trade," stating:

> As discussed previously and noted by many commenters, in some trades, industries, and/or geographic locations, PPE for employees who frequently change jobs can take on some of the qualities of a "tool of the trade." In other words, the PPE is an item that the employee traditionally keeps with his or her tool box. This may be because the PPE is used while performing some type of specialized work, such as welding or electrical work, or because it is a tradition in the industry, such as in home building. OSHA has not included an exception to the payment requirement for tools of the trade because, among other things, of the difficulty of defining, with adequate precision, when an item of PPE is or is not a tool of the trade. However, because the rule does not require employers to reimburse employees for PPE they already own, it recognizes that some employees may wish to own their tools of the trade and bring that equipment to the worksite.
>
> OSHA has further emphasized in the regulatory text that employees are under no obligation to provide their own PPE by stating that the employer shall not require an employee to provide or pay for his or her own PPE, unless the PPE is specifically excepted in the final rule. These provisions address the concern that employers not circumvent their obligations to pay for PPE by making employee ownership of the equipment a condition of employment or continuing employment or a condition for placement in a job. OSHA recognizes that in certain emergency situations, such as response to a natural disaster, where immediate action is required, it may be necessary for employers to hire or select employees already in possession of the appropriate PPE. As a general matter, however, employers must not engage in this practice. Taking PPE-ownership into consideration during hiring or selection circumvents the intent of the PPE standard and constitutes a violation of the standard. [72 FR 64358–64359]

The same rationale applies here.

OSHA also rejects the argument that, because FR and arc-rated clothing is secondary protection, the Agency should not require employers to pay for it. As noted earlier, PPE is part of a hierarchy of controls. OSHA standards typically require other forms of controls, such as engineering and work-practice controls, in preference to PPE. In many cases, PPE supplements engineering controls and forms a second line of defense to protect employees in the event that other types of controls do not provide complete abatement of the relevant hazard. For example, existing §§ 1910.67(c)(2)(v) and 1926.453(b)(2)(v) require employees working from aerial lifts to wear personal fall protection equipment because that PPE would protect the workers in case the engineering controls (that is, the guardrails or bucket walls on the aerial lift platforms or buckets) do not provide sufficient protection. (See, also, the preamble to the final rule on respiratory protection, 29 CFR 1910.134 and 29 CFR 1926.103, which notes: "Respiratory protection is a backup method which is used to protect employees from toxic materials in the workplace in those situations where feasible engineering controls and work practices are . . . not in themselves sufficient to protect employee health . . ." (63 FR 1156–1157, Jan. 8, 1998).) Consequently, OSHA standards often consider PPE "secondary" protection. FR and arc-rated clothing is not unique in this regard. In any event, where this final rule requires FR or arc-rated clothing, OSHA determined that it is necessary for employee protection (as described previously) and, thus, the rationale for requiring employers to pay for this type of PPE still applies.

In the PPE-payment rulemaking, OSHA also considered exempting types of PPE that were "personal in nature." [383] However, instead of

[383] For the purposes of this discussion, OSHA considers PPE that is "personal in nature" to be PPE fitted to an individual employee and not shared by

exempting all such personal PPE, the Agency chose to evaluate various types of personal PPE individually. First, OSHA chose not to require employer payment for everyday clothing or ordinary clothing used solely for protection from weather. The Agency explained the reasoning for this decision as follows:

OSHA does not believe that Congress intended for employers to have to pay for everyday clothing and ordinary clothing used solely for protection from the weather. While serving a protective function in certain circumstances, employees must wear such clothing to work regardless of the hazards found. OSHA is exercising its discretion through this rulemaking to exempt jeans, long sleeve shirts, winter coats, etc., from the employer payment requirement. As stated, this is consistent with OSHA's intent in the proposal and is also supported by the rulemaking record. A number of commenters stated that OSHA should exempt these items from the employer payment requirement . . .

Thus, OSHA is not requiring employers to pay for everyday clothing even though they may require their employees to use such everyday clothing items such as long pants or long-sleeve shirts, and even though they may have some protective value. Similarly, employees who work outdoors (e.g., construction work) will normally have weather-related gear to protect themselves from the elements. This gear is also exempt from the employer payment requirement. [72 FR 64349]

The PPE-payment rule also exempts nonspecialty safety-toe protective footwear, provided the employer permits employees to wear it off the jobsite.[384] OSHA explained this exemption as follows:

OSHA has historically taken the position that safety-toe protective footwear has certain attributes that make it unreasonable to require employers to pay for it in all circumstances . . . . Safety footwear selection is governed by a proper and comfortable fit. It cannot be easily transferred from one employee to the next. Unlike other types of safety equipment, the range of sizes of footwear needed to fit most employees would not normally be kept in stock by an employer and it would not be reasonable to expect employers to stock the array and variety of safety-toe footwear necessary to properly and comfortably fit most individuals.

Furthermore, most employees wearing safety-toe protective footwear spend the majority of their time working on their feet, and thus such footwear is particularly difficult to sanitize and reissue to another employee. Other factors indicate as well that employers should not be required to pay for safety-toe protective footwear in all circumstances. Employees who work in non-specialty safety-toe protective footwear often wear it to and from work, just as employees who wear dress shoes or other non-safety-toe shoes do. In contrast, employees who wear specialized footwear such as boots incorporating metatarsal protection are likely to store this type of safety footwear at work, or carry it back and forth between work and home instead of wearing it. . . . OSHA does not believe that Congress intended for employers to have to pay for shoes of this type.

For all of these reasons, OSHA has decided to continue to exempt nonspecialty safety shoes from the employer payment requirement. OSHA, however, also wants to make clear that this exemption applies only to non-specialty safety-toe shoes and boots, and not other types of specialty protective footwear. Any safety footwear that has additional protection or is more specialized, such as shoes with non-slip soles used when stripping floors, or steel-toe rubber boots, is subject to the employer payment requirements of this standard. Put simply, the exempted footwear provides the protection of an ordinary safety-toe shoe or boot, while footwear with additional safety attributes beyond this (e.g., shoes and boots with special soles) fall under the employer payment requirement. [72 FR 64348]

FR and arc-rated clothing is not "everyday clothing" or "ordinary clothing . . . used solely for protection from weather" as OSHA used those terms in the exemptions from the PPE-payment rule. This is not clothing that employees would purchase on their own to wear every day or to wear for protection against the weather. Although employees could wear it off the job, FR and arc-rated clothing command a premium above the price of normal clothing. OSHA estimates that a single set of flame-resistant apparel costs $191.75, on average. (See Section VI, Final Economic Analysis and Regulatory Flexibility Analysis, later in the preamble.) OSHA estimates that normal work clothing would cost half that amount. Winter-weather gear that is flame-resistant or arc-rated commands a greater premium. Evidence in the record indicates that non-FR winter wear may cost about $60 to $120, whereas similar FR winter wear could cost as much as $300 (Tr. 1024–1026).

In addition, FR and arc-rated clothing provides more than incidental protection. As explained earlier, manufacturers design these garments specifically to protect against clothing ignition and incident heat energy. Consequently, OSHA determined that the rationale for exempting "everyday clothing" and "ordinary clothing . . . used solely for protection from weather" from the final PPE-payment rule does not apply to FR or arc-rated clothing, and OSHA is not interpreting these exemptions specified in the PPE-payment rule as covering the FR and arc-rated clothing required by final § 1926.960(g).

FR and arc-rated clothing shares some attributes with nonspecialty safety-toe protective footwear. Employers normally may not keep in stock the range of sizes of pants, shirts, and other clothing needed to fit most employees,[385] and it would not be reasonable to expect employers to stock the array and variety of clothing necessary to properly and comfortably fit most individuals. In addition, employees who work in FR or arc-rated clothing may sometimes wear it to and from work, just like employees who wear ordinary clothing.

On the other hand, FR and arc-rated clothing does not have some of the other characteristics that formed the basis of OSHA's decision to exempt nonspecialty safety-toe protective footwear from PPE-payment requirements. FR clothing is not exempt from requirements for employer payment in other workplaces, such as steel plants, where an OSHA standard, such as § 1910.132(a), requires it. Furthermore, employers can sanitize this clothing easily for use by other employees. In fact, evidence in the record indicates that some employers currently use uniform-supply companies to provide and launder FR and arc-rated clothing (Ex. 0230). In addition, employers can purchase arc-rated clothing in a wide variety of ratings and are in a better position to make purchasing decisions with respect to arc rating than employees, which is not true of nonspecialty safety-toe protective footwear. OSHA concludes that FR and arc-rated clothing do not have all the attributes on which the Agency based its rationale for exempting nonspecialty safety-toe protective footwear; and, therefore, OSHA is not granting a similar exemption from the employer payment requirements for this clothing.

Moreover, OSHA believes that the record in this rulemaking demonstrates that, similar to most OSHA requirements for PPE, employee safety will significantly benefit from a requirement that employers provide FR and arc-rated clothing at no cost to employees. Employers generally need to ensure that the clothing worn by

other employees and that the employee can use off the job.

[384] The PPE-payment rule provides additional exemptions for such items as nonspecialty prescription safety eyewear. However, the rationale behind those exemptions sheds no additional light on whether FR and arc-rated clothing should or should not be subject to the general employer-payment requirement.

[385] There are ways to provide FR and arc-rated clothing to employees that do not require the employer to maintain stocks of clothing, including using a clothing rental or uniform service and providing a clothing allowance so that employees can purchase their own clothing (Tr. 1134).

employees has an arc rating at least as high as the employer's incident-energy estimates. Selecting the proper clothing sometimes will involve determining the rating of an entire clothing system; such a determination is likely beyond the capability of individual employees, but is within an employer's capability. For example, Dr. Thomas Neal testified:

> [T]he only sure way [to obtain a rating for a layered clothing system] is to measure the arc rating for the system. [I]t's not [a] situation where you could have an arc rating for three different layers that you put those on top of each other, just add them together. That doesn't work. [Tr. 500]

In addition, as discussed later in this section of the preamble, clothing maintenance can substantially impact the ability of FR and arc-rated clothing to protect employees. Employers are in a better position to make purchasing decisions based on clothing maintenance needs than employees.

While considerations regarding clothing selection and maintenance address principally arc-rated clothing, the Agency believes that requiring employers to purchase arc-rated but not FR clothing would cut too fine a line through OSHA's rationale. It is OSHA's understanding that most FR clothing, especially work clothing, has an arc rating (Tr. 545), and the Agency believes that employers will use arc-rated clothing (which is always flame-resistant) to meet the requirement in final paragraph (g)(4) for FR clothing. In this regard, it seems unlikely that employers will purchase one set of clothing to meet final paragraph (g)(4) and a different set of clothing to meet final paragraph (g)(5).

Some employers recommended that OSHA exempt clothing of various types, or having a specified minimum arc rating, from any requirement that employers pay for FR or arc-rated clothing. (See, for example, Exs. 0125, 0149, 0167; Tr. 295–297.) For instance, Mr. Ward Andrews with Wilson Construction recommended that employees come to the job in a minimum level of protective clothing and that employers pay for any higher level of protection needed for a particular exposure (Tr. 295–297). He justified his recommendation as follows:

> [I]t is our belief that journeyman linemen should come to work with basic tools. And we believe a Level one FR garment would be a basic tool to do his everyday task.
>
> [O]ur position is that they should come to work with those basic tools. And that is the minimum level one protection for the average distributional circuit here in America.
>
> * * * * *
>
> So we agree that at level one, basic [attire] should be clothing, as part of their job requirement, to step on. And then as they associate a job with hazards, and a higher level of protection needs to be provided, then surely that contractor should provide those additional levels.
>
> [W]e look [at] a journeyman lineman today, and we realize that he brings in his climbing belt, his positioning belt, his skid, his line boots. I believe that his positioning belt falls under—his line belt is a positioning belt, which is considered personal protective equipment. They provide that as tool that they bring to the job. So once again, I think that's evidence to—the same thing as a shirt, a very basic component that they should wear as journeyman lineman.
>
> They provide their own raingear. They provide their own clothing right now. Your rule as proposed would say the most outer garment should be FR resistant. I believe that these basic tools that they now require, they should still provide, and you should give them time to buy FR raingear and clothes. [Tr. 295–297]

This argument is identical to the argument made for tools of the trade. In the PPE-payment rulemaking, OSHA rejected that argument for tools of the trade, as described earlier, and the Agency rejects this argument as it applies to FR and arc-rated clothing for the same reasons.

For the foregoing reasons, OSHA determined that employers must provide FR and arc-rated clothing at no cost to employees, and OSHA is not exempting this protective clothing from the PPE-payment rule. The requirements in §§ 1910.132(h) and 1926.95(d) apply to FR and arc-rated clothing; and, therefore, OSHA is not adding PPE-payment provisions to § 1910.269 or Subpart V.[386]

Some employees performing work covered by this final rule may already own FR or arc-rated clothing. The PPE-payment requirements in §§ 1910.132(h)(6) and 1926.95(d)(6) provide that, when an employee provides adequate protective equipment that he or she owns, the employer may allow the employee to use it and need not reimburse the employee for the equipment. However, those provisions also prohibit the employer from requiring an employee to provide or pay for his or her own PPE, unless the PPE-payment requirement exempts the PPE. Accordingly, paragraph (h)(6) of § 1910.132 and paragraph (d)(6) of § 1926.95 apply to the FR and arc-rated clothing required by this final rule.

Maintenance of FR and arc-rated clothing. Some rulemaking participants stressed the importance of proper maintenance of the FR and arc-rated clothing required by the standard (Exs. 0130, 0186, 0325; Tr. 830–831, 834–839). For example, NIOSH stated that "[c]lothing maintenance is required for arc-rated FR clothing to provide continued protection at its rated arc thermal performance value" (Ex. 0130). Mr. Eric Frumin with UNITE HERE testified:

> Regarding the FR uniform programs in which the employees wash the garments themselves, there are number of factors that make it difficult or impossible for employees themselves to preserve the FR characteristics of the garments, contamination of the garment, inadequate training about the proper care of the garment, how do you maintain the physical integrity of it, the proper materials to use for repairing defects, proper laundering techniques, what kinds of cleaning agents or bleaching agents to avoid and so forth.
>
> And of course maintaining a proper number of garments to be available so that workers always have them. . . .
>
> A number of these problems are mentioned in the standard, [ASTM] 1449 and recommends the use of professional laundering services. Likewise NIOSH in its comments for this hearing said, "The emphasis that manufacturers place on proper laundering to maintain the FR characteristics of their garment suggests the need for professional laundering." So these are important things for OSHA to be mindful of as far as possibly assur[ing] that quality of the FR garments is maintained even when employees are washing the garments themselves.
>
> Now I would like to address that question of maintenance of consistent high quality laundering of FR clothing. Employers have a critical role to play here and that's envisioned in the ASTM standard. Likewise, NFPA 70E talks about the need specifically for careful inspection of clothing and kinds of interferences, contamination, damage and takes the position that defective clothing shall not be used. Very important. [Tr. 835–836]

Mr. Frumin cited two examples of a contract uniform service that failed to properly maintain the FR clothing they serviced (Tr. 836–838). Mr. John Devlin with the Utility Workers Union of America also described examples of inadequate maintenance of FR clothing:

> This shirt was sent in several times and it continually came back with a hole that was never repaired even though it was requested twice. These pants were sent out twice with the repair tag for the frayed bottoms of the trousers to be either shortened or repaired in some manner. The answer that Cintas did was they sent back a pair of new trousers. The only problem there was no belt loops. [Tr. 821]

Mr. Frumin urged OSHA to "require . . . employers to obtain with each delivery a certification from their suppliers that the correct number of garments has been provided, that they

[386] OSHA does not consider the FR and arc-rated clothing required by this final rule to be the type of everyday or ordinary clothing exempted from the PPE-payment rules in §§ 1910.132 and 1926.95.

are free of defects and contamination that could compromise the FR protection" (Tr. 838).

The record indicates that there are a variety of methods currently in use to maintain FR and arc-rated clothing. Some employers have their employees launder and maintain this clothing. (See, for example, Tr. 305–306, 1192–1193.) Other employers hire laundering or uniform services to perform those functions. (See, for example, Tr. 388, 821.) OSHA stresses that §§ 1910.132(a) and (b) and 1926.95(a) and (b) require employers to properly maintain FR and arc-rated clothing required by this final rule. These provisions make PPE maintenance the responsibility of employers, not employees. The Agency is declining to adopt Mr. Frumin's suggestion to require employers to have suppliers certify that each delivery of FR clothing is free of defects and contamination because OSHA believes that it is the employer's responsibility to ensure proper maintenance of PPE. There are ways of ensuring proper maintenance of FR and arc-rated clothing that do not rely on the certification of a supplier. For example, employers can inspect this clothing before accepting it, and they can return it to the supplier if they find defects or contaminants on the clothing. In any event, the responsibility for maintaining PPE rests squarely with the employer under existing OSHA standards.

The Agency is not prohibiting home laundering of FR and arc-rated clothing. However, to comply with § 1910.132 or § 1926.95, employers cannot simply instruct employees to follow manufacturers' instructions.[387] If employers rely on home laundering of the clothing, they must train their employees in proper laundering procedures and techniques, and employers must inspect the clothing on a regular basis to ensure that it is not in need of repair or replacement. Evidence in the record indicates that some employers already are performing these functions. (See, for example, Tr. 1193.)

Protecting employees from flying debris from electric arcs. Two rulemaking participants recommended that OSHA require protection from flying debris that results from electric arcs (Exs. 0340, 0342, 0378; Tr. 253–268, 274–283). Mr. Nestor Kolcio with 2K Consultants argued that a substantial number of injuries result from the flying debris, which he called "fragmentation" or "shrapnel," released in an electric arc-flash incident (Ex. 0342). Using OSHA's preliminary regulatory analysis as a baseline, he estimated that 17 injuries from flying debris occur annually in work covered by the final rule (*id.*). He stated that these injuries result from work activities such as pulling fuses and end caps, working on dead-front transformers, installing lightning arresters, and operating load-break switches (*id.*). Mr. Jim Stillwagon with Gary Guard described injuries that occurred from flying debris caused by electric arcs, including an eye injury and a chest injury in which debris "settled in the [worker's] aort[ic] valve" (Tr. 276–280). Mr. Kolcio and Mr. Stillwagon recommended that OSHA require protection, in the form of shields on live-line tools, from injuries caused by flying debris resulting from electric arcs that occur when employees are using live-line tools (Tr. 268, 274–275). Mr. Kolcio also noted that the existence of IEEE and ASTM standards covering these shields, as well as various scientific papers, indicated the need for such protection (Tr. 265–267).

OSHA agrees with Messrs. Kolcio and Stillwagon that electric arcs pose hazards in addition to the thermal hazards addressed by the final rule. Dr. Mary Capelli-Schellpfeffer testified that electric arcs can result in "sprayed or blown hot or melting installation elements, moved by the mechanical forces in the electric arc event" (Tr. 187). Also, NFPA 70E–2004 warned that "[d]ue to the explosive effect of *some arc events,* physical trauma injuries could occur" (Ex. 0134; emphasis added).[388] OSHA expects that the hazard analysis required by paragraph (g)(1) in the final rule will identify nonthermal hazards, including physical trauma hazards posed by flying debris, associated with employee exposure to electric arcs. Although the final rule does not address these hazards, OSHA's existing general PPE requirements, for example, §§ 1910.132 and 1926.95, require employers to address them. Those standards require employers to provide shields and barriers necessary to protect employees from physical trauma hazards. However, as noted by NFPA 70E, not all arc events pose physical trauma hazards from flying debris; therefore, this protection will not always be necessary, and the Agency concludes that this final rule does not have to address these hazards further.

Compliance deadlines for certain provisions in paragraph (g). The final rule includes a new paragraph (g)(6) setting a compliance deadline of January 1, 2015, for the requirement in paragraph (g)(2) that the employer make reasonable estimates of incident energy and a compliance deadline of April 1, 2015, for: (1) the requirement in paragraph (g)(4)(iv) that the employer ensure that the outer layer of clothing worn by an employee is flame-resistant when the estimated incident heat energy exceeds 2.0 cal/cm^2 and (2) the requirement in paragraph (g)(5) that the employer ensure that each employee exposed to hazards from electric arcs wears the necessary arc-rated protection. These deadlines are described more fully in Section XII, Dates, later in this preamble.

Fuse handling, covered conductors, non-current-carrying metal parts, and opening circuits under load. The remaining provisions in final § 1926.960 deal with handling fuses, covered (noninsulated) conductors, non-current-carrying metal parts, and opening and closing circuits under load. To protect employees from contacting energized parts, paragraph (h) of final § 1926.960 requires employers to ensure that employees installing and removing fuses use tools or gloves rated for the appropriate voltage if one or both terminals are energized at over 300 volts or if exposed parts are energized at more than 50 volts. When an expulsion fuse operates on a fault or overload, the arc from the fault current reacts with an agent in the tube. This reaction produces hot gas that blasts the arc through the fuse tube vent or vents, and with it any loose material in its path. The arc blast or particles blown by the blast could injure employees' eyes. Employers must ensure that employees do not install or remove such fuses using rubber insulating gloves alone. Therefore, final paragraph (h) also requires employees installing or removing expulsion-type fuses with one or both terminals energized at more than 300 volts to wear eye protection, use a tool rated for the voltage, and be clear of the fuse barrel's exhaust path. (See, also, the discussion of protection from flying debris under the summary and explanation for paragraph (g) of the final rule earlier in this section of the preamble.) OSHA adopted this paragraph, which has no counterpart in existing Subpart V, from existing § 1910.269(l)(7).

Proposed paragraph (h) provided that employees use eye protection only during expulsion fuse installation. Mr.

[387] See also a memorandum from Richard E. Fairfax, Director, Directorate of Enforcement Programs, and Steven Witt, Director, Directorate of Cooperative and State Programs, dated March 19, 2010, detailing OSHA's enforcement policy for flame-resistant clothing in oil and gas drilling, well servicing, and production-related operations *http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=27296.*

[388] NFPA 70E–2012 contains the same warning in Informational Note No. 1 to Section 130.7(A).

Nestor Kolcio presented data indicating that employees sustained injuries associated with electric arcs when the employees were removing, as well as installing, fuses or end caps (Ex. 0342). As noted earlier, Mr. Kolcio recommended that the standard require employees to be protected from flying debris associated with electric arcs.

Based on Mr. Kolcio's data, OSHA concludes that protection from the material expelled from expulsion-type fuses is necessary for employees removing, as well as installing, them. Therefore, final paragraph (h) requires the same protection for employees removing expulsion-type fuses as for employees installing such fuses.

The Virginia, Maryland and Delaware Association of Electric Cooperatives recommended that this paragraph include the term "live-line tool" to make it clear that the provision was not requiring a special tool designed specifically for handling fuses (Ex. 0175).

A live-line tool is one type of insulated tool. Paragraph (h) of the final rule permits fuse handling with any type of insulated tool, including a live-line tool. This provision was clear in the proposed rule. Therefore, OSHA is not adopting the recommendation from the Virginia, Maryland and Delaware Association of Electric Cooperatives.

Final paragraph (i) explains that the requirements of § 1926.960 that pertain to the hazards of exposed live parts also apply when employees perform work in proximity to covered (noninsulated) conductors. That is, the final standard treats covered conductors as uninsulated. (See the definition of "covered conductor" in final § 1926.968.) The covering on this type of wire protects the conductor from the weather, but does not provide adequate insulating value. OSHA took this provision, which has no counterpart in existing Subpart V, from existing § 1910.269(l)(8). The Agency received no comments on this provision and is adopting it with only editorial changes from the proposal.

Final paragraph (j) requires that non-current-carrying metal parts of equipment or devices be treated as energized at the highest voltage to which those parts are exposed unless the employer inspects the installation and determines that the parts are grounded. Grounding these parts, whether by permanent grounds or by the installation of temporary grounds, provides protection against ground faults and minimizes the possibility that non-current-carrying metal parts of equipment and devices will become energized. OSHA based this requirement, which has no counterpart in existing Subpart V, on existing § 1910.269(l)(9). OSHA received no comments on this provision and is adopting it in the final rule without substantive change from the proposal.

Paragraph (k) in the proposed rule provided that employers ensure the use of devices designed to interrupt the current involved to open circuits under load conditions. This proposed requirement had no counterpart in existing Subpart V; OSHA adopted it from existing § 1910.269(l)(10).

The Ameren Corporation requested that OSHA clarify that this provision only applies to switches and breakers (Ex. 0209). Ameren believed that this interpretation was consistent with the 1994 rulemaking record for existing § 1910.269(l)(10) (*id.*). In that rulemaking, OSHA explained the rationale for this provision as follows:

> The National Electrical Manufacturers Association (NEMA) urged OSHA to add a requirement for opening circuits under load only with devices intended to interrupt current (Ex. 3–81). Edison Electric Institute recommended adoption of a similar requirement (Ex. 28). The Agency agrees with EEI and NEMA that it is hazardous to open a circuit with a device that is not designed to interrupt current if that circuit is carrying current. Non-load-break switches used to open a circuit while it is carrying load current could fail catastrophically, severely injuring or killing any nearby employee. Therefore, OSHA has adopted a requirement that devices used to open circuits under load conditions be designed to interrupt the current involved . . . . [59 FR 4390]

The Agency disagrees with Ameren that this provision applies only to switches and circuit breakers. The preamble to the 1994 rulemaking mentioned non-load-break switches as an example of a type of device that could fail catastrophically. However, the rationale and the rule apply similarly to any device that is not capable of interrupting load current. In addition, a similar provision in the 2002 NESC, quoted in the next paragraph, applies to "switches, circuit breakers, or other devices." The OSHA provision applies to other devices in addition to switches and circuit breakers. Therefore, OSHA is not adopting the change requested by Ameren.

IBEW recommended that OSHA expand proposed paragraph (k) to cover devices used to pick up load or close circuits (Ex. 0230). Rule 443E of the 2002 NESC [389] supports IBEW's position; the NESC provision addresses the opening and closing of circuits under load as follows:

> When equipment or lines are to be disconnected from any source of electric energy for the protection of employees, the switches, circuit breakers, or other devices designated and designed for operation under the load involved at sectionalizing points shall be opened or disconnected first. When re-energizing, the procedure shall be reversed. [Ex. 0077]

OSHA recognizes that closing a circuit onto a load poses the same hazards as opening a circuit under load. In either case, heavy current can cause a device to fail if the design of that device is not such that it can safely interrupt or pick up load current. Therefore, OSHA is adopting IBEW's recommendation by adding a new paragraph (k)(2), that reads as follows: "The employer shall ensure that devices used by employees to close circuits under load conditions are designed to safely carry the current involved." OSHA is adopting proposed paragraph (k) without substantive change as paragraph (k)(1) in the final rule.

12. Section 1926.961, Deenergizing Lines and Equipment for Employee Protection

Section 1926.961 of the final rule addresses the deenergizing of electric transmission and distribution lines and equipment for the protection of employees. Transmission and distribution systems are different from other energy systems found in general industry or in the electric utility industry. The hazardous energy control methods for these systems are necessarily different from the methods covered under the general industry standard on the control of hazardous energy sources (§ 1910.147). As explained in the preamble to the 1994 final rule on existing § 1910.269, electric utilities install transmission and distribution lines and equipment outdoors; consequently, these lines and equipment are subject to reenergization by means other than normal energy sources (59 FR 4390). For example, lightning can strike a line and energize a deenergized conductor, or unknown cogeneration sources not under the control of the employer can energize a line. Additionally, some deenergized transmission and distribution lines are subject to reenergization by induced voltage from nearby energized conductors or by contact with other energized sources of electrical energy. Another difference is that energy control devices often are remote from the worksite and are frequently under the centralized control of a system operator.

[389] The 2012 NESC contains the same requirement in Rule 443E.

For these reasons, OSHA is adopting requirements for the control of hazardous energy sources related to transmission and distribution systems. This is the same approach used in existing § 1910.269. In this regard, OSHA developed the requirements proposed in § 1926.961 from existing § 1910.269(m). Existing Subpart V also contains procedures for deenergizing transmission and distribution installations. OSHA discusses the differences between existing § 1926.950(b)(2) and (d) and final § 1926.961 later in this preamble.

OSHA is promulgating paragraph (a) of the final rule without change from the proposal. Final paragraph (a) describes the application of § 1926.961 and explains that conductors and equipment that have not been deenergized under the procedures specified by § 1926.961 have to be treated as energized.

Ms. Susan O'Connor with Siemens Power Generation recommended that OSHA require that live parts be deenergized "unless the employer can demonstrate that deenergizing introduces additional or increased hazards or is infeasible due to equipment design or operational limitations" (Ex. 0163).

It is true that other OSHA standards that protect employees from hazardous energy (such as the general industry lockout-tagout standard at § 1910.147 and the electrical lockout and tagging requirements at § 1910.333(a)(1) and (b)(2)) generally require employers to deenergize energy sources. OSHA nevertheless rejects Ms. O'Connor's recommendation because there is insufficient information in the record to determine whether the recommendation is economically or technologically feasible. First, Ms. O'Conner did not include information in her comment on whether deenergizing transmission and distribution lines and equipment would be economically and technologically feasible. Second, Federal and local government agencies regulate the reliability of electric power systems, thereby limiting electric utilities' ability to deenergize transmission and distribution circuits.[390] Finally, the record in this rulemaking demonstrates that: (1) Electric utilities and their contractors routinely work on energized lines and equipment and (2) deenergizing transmission and distribution circuits can involve significant cost and practicability issues. (See, for example, Exs. 0573.1, 0575.1.) For instance, EEI stated that "[p]lanning and scheduling for an outage [on a transmission circuit] can require as little as 1 month and 3 day notification to as long as 6 months and 3 days depending on the outage length" (Ex. 0575.1).

Some systems are under the direction of a central system operator who controls all switching operations. Other systems (mostly distribution installations) are not under any centralized control. Electric utilities energize and deenergize these systems in the field without the direct intervention of a system operator. Paragraph (b)(1) of the final rule states that employers must designate one employee in the crew as being in charge of the clearance and must comply with all of the requirements of paragraph (c) if a system operator is in charge of the lines and equipment and of their means of disconnection. (Paragraph (c), which OSHA discusses in detail later, sets procedures that employers must follow when deenergizing lines and equipment.) OSHA is adopting final paragraph (b)(1) as proposed with one clarification. This provision in the final rule makes clear that the employer must designate the employee in charge of the clearance. Final paragraph (c)(1) requires the "designated" employee in charge to request the clearance, and final paragraph (b)(2) (described in the next paragraph in this preamble) requires the employer to designate the employee in charge when there is no system operator. OSHA included an explicit requirement in final paragraph (b)(1) that the employer designate the employee in charge when there is a system operator to clarify that designating the employee in charge is the employer's responsibility whether or not there is a system operator.

Final paragraph (b)(2), which is also being adopted without substantive change from the proposal, sets requirements for crews working on lines or equipment that are not under the control of a system operator.[391] When final paragraph (b)(2) applies, the employer must designate one employee on the crew to be in charge of the clearance. In this case, final paragraph (b)(2) provides that, except as provided in final paragraph (b)(3), all of the requirements in final paragraph (c) apply and provides that the employee in charge of the clearance perform the functions that the system operator would otherwise perform.

Final paragraph (b)(3) exempts a portion of the requirements of final paragraph (c) from applying to work performed by a single crew of employees if the means of disconnection of the lines and equipment are accessible and visible to, and under the sole control of, the employee in charge of the clearance. The provisions of final paragraph (c) that do not apply are those relating to: (1) Requesting the system operator to deenergize the lines and equipment (final paragraph (c)(1)), (2) automatic and remote control of the lines (final paragraph (c)(3)), and (3) the wording on tags (final paragraph (c)(5)). Final paragraph (b)(3) also provides that employers need not use the tags required by the remaining provisions of final paragraph (c).[392] It is not necessary to request the system operator to deenergize the lines or equipment because he or she would not be in control of the disconnecting means for the lines or equipment. When paragraph (b)(3) applies, employers do not need tags for the protection of the crew because only one person would be in charge of the clearance for the crew, and the means of disconnection for the lines or equipment would be accessible and visible to, and under the control of, that person. Finally, OSHA exempted the provision addressing remote and automatic switching of lines and equipment because, again, the means of disconnection must be accessible and visible to, and under the sole control of, the employee in charge of the clearance.

Final paragraph (b)(4) addresses work situations in which a group of employees consists of several "crews" of employees working on the same lines or equipment. Final paragraph (b)(4)(i) provides that employers may treat these crews as a single crew when they are under the direction of a single employee in charge of the clearance for all of the crews and they are working in a coordinated manner to accomplish a task on the same lines or equipment. In such cases, the employer must ensure

[390] For example, section 215 of the Federal Power Act, 16 U.S.C. 824o, requires a Federal Energy Regulatory Commission-certified Electric Reliability Organization to develop mandatory and enforceable reliability standards, which are subject to review and approval by the Commission. Electric utilities ultimately must meet those reliability standards. (See also 18 CFR Part 40; Ex. 0545.1.)

[391] If there are multiple circuits involved with some lines or equipment under the control of a system operator and the others not under system-operator control, the lines or equipment that are under the control of a system operator fall under paragraph (b)(1), and the ones that are not under such control fall under paragraph (b)(2).

[392] The proposed rule was similar, except that it exempted an additional provision, proposed paragraph (c)(11), which addressed the removal of tags. In the final rule, the corresponding provision, in paragraph (c)(12), clarifies that "[n]o one may remove tags without the release of the associated clearance as specified under paragraphs (c)(10) and (c)(11) of this section." Even though final paragraph (b)(3) does not require tags, when that paragraph applies, final paragraph (c)(12) should not be exempted. It is important that members of a crew not remove tags that are placed for the protection of other crews.

that employees coordinate all operations that could energize or deenergize a circuit through a single employee in charge, as required in final paragraphs (b) and (c). OSHA notes that, if paragraph (b)(4)(i) does not apply, employers must treat the crews as independent crews (see the discussion of final paragraph (b)(4)(ii) in the following paragraph), and each independent crew must have an employee in charge, as required by final paragraphs (b) and (c).[393]

Final paragraph (b)(4)(ii) provides for the situation in which more than one independent crew is working on the same line or equipment. Under the final rule, in such circumstances: (1) Each crew must follow separately the steps outlined in final paragraph (c); and, (2) if there is no system operator in charge of the lines or equipment, each crew must have separate tags and coordinate deenergizing and reenergizing the lines and equipment with the other crews. The purpose of the provision is to ensure that a group of workers does not make faulty assumptions about what steps another group took or will take to deenergize and reenergize lines or equipment.

OSHA adopted the provisions in final paragraph (b)(4)(ii), which require each independent crew to comply independently with paragraph (c) and each crew to coordinate deenergizing and reenergizing the lines or equipment with the other crews if there is no system operator in charge of the lines or equipment, from proposed paragraph (b)(3)(ii). Final paragraph (b)(4)(i), and the provision in final paragraph (b)(4)(ii) requiring a separate tag for each crew if there is no system operator in charge of the lines or equipment, are new provisions that were not in the proposal. OSHA is adopting the new provisions after examining comments on whether the standard should require each crew to have a separate tag.

Several commenters argued that separate tags for each crew are unnecessary (Exs. 0126, 0175, 0177, 0201, 0209, 0220, 0227). These commenters maintained that crews working on the same circuits typically coordinate their activities and work under a single person with authority over the clearance. For example, Duke Energy stated:

> Multiple crew tagging could create confusion and will result in insufficient coordination between the crews. If one person is in charge of multiple crews in a work group, one tag is sufficient for that group of crews. If each crew has a person placing tags, the probability of error increases. If a single tag is applied, then the employee in charge will be responsible to verify that it is placed correctly. Considering multiple crews working in a coordinated manner as one crew for the purpose of tagging ensures that the employee in charge will maintain control over the entire situation. Multiple tagging complicates coordination of the work effort. [Ex. 0201]

Other commenters stated that when multiple crews work independently, without a single employee responsible for the clearance, they should use separate tags for each crew (Exs. 0186, 0210, 0212, 0219, 0225, 0230). For example, Mr. Anthony Ahern with the Ohio Rural Electric Cooperatives commented:

> Every independent crew working on a line that is protected by the same disconnect device should have their own tag in place. This is particularly important in storm or emergency restoration work. It is simply too easy to lose track of crews, even with a system [operator]. If each crew tags the disconnect, then it simply is not allowed to be operated until all crews remove their tags. This is the only real way to ensure that everyone is accounted for and in the clear. There could be a procedure where a crew could grant someone else permission to remove their tag if they were a long distance away and it would require an extended amount of time for them to go back to the disconnect location. But because they did have a tag at the disconnect they were still contacted and accounted for. This should also be a requirement for line-clearance tree-crews. Quite often they are working on clearing a section of line and other line crews don't know they are there. [Ex. 0186]

Southern Company commented:

> We agree that when two independent crews are working under a system operator that each crew should have their own clearance but a single tag issued by the system operator is sufficient. . . . There may be situations where the "independent" crews do not want to coordinate their activities. The standard should require in those situations that each independent crew have their own tag on the lines or equipment. [Ex. 0212]

After considering these comments, OSHA concludes that employers may treat crews working in a coordinated manner under a single employee holding the clearance as a single crew. Such crews act as a single crew, and the Agency believes that requiring separate tags would not increase worker safety. OSHA drafted final paragraph (b)(4)(i) accordingly.

In the 1994 § 1910.269 rulemaking, the Agency explained its decision regarding the issue of whether employers must use separate tags for independent crews as follows:

> Three commenters stated that some utilities use one tag for all crews involved, maintaining a log to identify each crew separately . . . . They recommended that the standard allow this practice to continue.
>
> Paragraph (m)(3) of final 1910.269 does not require a separate tag for each crew (nor did paragraph (m)(3) in the proposal); it does require, however, separate clearances for each crew. There must be one employee in charge of the clearance for each crew, and the clearance for a crew is held by this employee. In complying with paragraph (m)(3)(viii), the employer must ensure that no tag is removed unless its associated clearances are released (paragraph (m)(3)(xii)) and that no action is taken at a given point of disconnection until all protective grounds have been removed, until all crews have released their clearances, until all employees are clear of the lines or equipment, and until all tags have been removed at that point of disconnection (paragraph (m)(3)(xiii)). [59 FR 4393]

If a system operator controls clearances, employers may use a log or other system to identify each crew working under a single tag (269-Exs. 3–20, 3–27, 3–112). When each crew releases its clearance to the system operator, that signals to the system operator that each employee in the crew received notification that release of the clearance is pending, that all employees in the crew are in the clear, and that all protective grounds for the crew have been removed. (See final paragraph (c)(10).) The system operator cannot take action to restore power without the release of all clearances on a line or equipment. (See final paragraphs (c)(12) and (c)(13).)

However, without a system operator, each independent crew would have no way of knowing the exposure status of other crews without separate tags. When the crews are truly independent and there is no system operator, there would be no way to determine that all crew members are clear of energized parts or that all the crew's protective grounds have been removed unless each crew uses a separate tag. Consequently, OSHA decided to adopt a requirement in final paragraph (b)(4)(ii) that, whenever there is no system operator, each crew must (1) have separate tags (this is a new provision not in the proposal) and (2) coordinate deenergizing and reenergizing the lines or equipment with other crews (OSHA adopted this provision from proposed paragraph (b)(3)(ii)). Final paragraph (b)(4)(ii) also carries forward the requirement from proposed paragraph (b)(3)(ii) that independent crews independently comply with § 1926.961 whether or not there is a system operator.

It is apparent that commenters did not completely understand the discussion of how the proposal treated separate

[393] OSHA notes that this interpretation of the word "crew" applies only to § 1926.961(b)(3). The interpretation does not apply to other provisions in the final rule addressing the work of two or more crews.

crews. Even though the preamble to the proposal indicated that OSHA would treat separate crews coordinating their activities and operating under a single employee in charge of the clearance as a single crew (70 FR 34871), several commenters appeared to believe that the Agency was considering separate tags for each crew in such circumstances. (See, for example, Exs. 0175, 0201.) Therefore, the final rule provides separate requirements for (1) single crews working with the means of disconnection under the sole control of the employee in charge of the clearance (final paragraph (b)(3)), (2) multiple crews coordinating their activities with a single employee in charge of the clearance for all of the crews (final paragraph (b)(4)(i)), and (3) multiple crews operating independently (final paragraph (b)(4)(ii)). This approach should clarify the application of the final rule to multiple crews.

OSHA is adding new titles to final paragraphs (b)(3) and (b)(4) to clarify their content. The title of final paragraph (b)(3) is "Single crews working with the means of disconnection under the control of the employee in charge of the clearance." Although this provision applies to a single crew, OSHA limited its application to circumstances in which the means of disconnection is accessible and visible to, and under the sole control of, the employee in charge of the clearance. The revised title makes this limitation clear. Thus, this paragraph applies to a special subset of instances in which employees are working as a single crew; it is not generally applicable.[394]

However, final paragraph (b)(4), pertaining to multiple crews, applies unconditionally, whenever more than one crew is working on the same lines or equipment. OSHA believes that the purpose of this paragraph will be clearer under its own title, "Multiple crews." With these new titles, the final rule clearly states the purposes of the paragraphs and closely follows the procedures described in the rulemaking record.

Paragraph (b)(5) of the final rule requires the employer to render inoperable any disconnecting means that are accessible to individuals not under the employer's control.[395] For example, the employer must render inoperable a switch handle mounted at the bottom of a utility pole that is not on the employer's premises to ensure that the overhead line remains deenergized. This requirement prevents a member of the general public or an employee who is not under the employer's control (such as an employee of a contractor) from closing the switch and energizing the line. OSHA adopted this requirement, which has no counterpart in existing Subpart V, from existing § 1910.269(m)(2)(iv). OSHA received no comments on this provision, which was proposed as paragraph (b)(4), and is adopting it substantially as proposed.

Paragraph (c) of the final rule sets forth the exact procedure for deenergizing transmission and distribution lines and equipment. Employers must follow the procedure in the order specified in paragraph (c), as provided in paragraphs (b)(1) and (b)(2). Except as noted, the rules are consistent with existing § 1926.950(d)(1), although OSHA took the language from existing § 1910.269(m)(3).

Paragraph (c)(1) of the final rule requires an employee to request the system operator to deenergize a particular section of line or equipment.[396] So that control is vested in one authority, a single designated employee is assigned this task. The employer must assign this task to a single designated employee to ensure that only one employee is in charge of, and responsible for, the clearance for work. OSHA adopted this provision, which has no counterpart in existing Subpart V, from existing § 1910.269(m)(3)(i). The designated employee who requests the clearance need not be in charge of other parts of the work; in the final rule, this designated employee is in charge of the clearance. He or she is responsible for requesting the clearance, for informing the system operator of changes in the clearance (such as transfer of responsibility), and for ensuring that, before the clearance is released, it is safe to reenergize the circuit. OSHA received no comments on this provision and is adopting it substantially as proposed.

When an employee requests a clearance in advance, the employees who will be performing the actual work would not necessarily have notice of this request and would not be in position to answer questions about the clearance. Therefore, if someone other than an employee at the worksite requests a clearance and if that clearance is in place before the employee arrives at the site, then that employee will need to transfer the clearance, pursuant to final paragraph (c)(9), to an on-site employee responsible for the work (such as an employee on the crew or a supervisor for the crew).[397] This transfer must occur before the work begins so that the system operator can inform the on-site employees of any alterations in the clearance. The Agency believes that the employee holding the clearance must, after the system operator deenergizes the lines and equipment, serve as the point of contact in case alterations in the clearance, such as restrictions in the length or extent of the outage, are necessary.

Paragraph (c)(2) of the final rule requires the employer to open all disconnecting means, such as switches, disconnectors, jumpers, and taps, through which electrical energy could flow to the section of line or equipment. This provision also requires the employer to render the disconnecting means inoperable if the design of the device permits. For example, the employer could detach the removable handle of a switch. The final rule also requires that the disconnecting means

[394] Existing § 1926.950(d) also recognizes deenergizing procedures that are not generally applicable. These alternative procedures, which apply when "[w]hen a crew working on a line or equipment can clearly see that the means of disconnecting from electric energy are visibly open or visibly locked-out," require: (1) Guards or barriers to be installed to protect against contact with adjacent lines (existing paragraph (d)(2)(i)), and (2) the designated employee in charge, upon completion of work, to determine that all employees in the crew are clear and that protective grounds installed by the crew have been removed, and to report to the designated authority that all tags protecting the crew may be removed (existing paragraph (d)(2)(ii)). Unlike final § 1926.961, existing § 1926.950(d)(2) specifies no procedures for deenergizing, testing, or grounding lines and equipment. OSHA concluded in the 1994 § 1910.269 rulemaking that requirements for deenergizing, testing, and grounding are necessary for employee protection (59 FR 4390–4391). Therefore, OSHA concludes that the existing alternative procedures are inadequate to ensure worker safety.

[395] Note that this provision, unlike paragraph (c)(2), requires employers to render disconnecting means inoperable regardless of whether the design of the disconnecting means permits this capability. When the design of the disconnecting means does not permit this capability, employers then must install some additional means, such as a lockable cover, to render the disconnecting means inoperable when required under paragraph (b)(5).

[396] If there is no system operator in charge of the lines or equipment or their means of disconnection, the employer must ensure, pursuant to final paragraph (b)(2), that the designated employee performs the functions that the system operator would otherwise perform. This means, with respect to final paragraph (c)(1), that the employer must ensure that the designated employee takes appropriate action to deenergize the particular section of line or equipment.

[397] Although the language in paragraph (c) does not state explicitly that the employee in charge must be at the worksite, the employee in charge is responsible, under paragraph (c)(10), for (1) notifying each employee under his or her direction of the pending release of the clearance, (2) ensuring that all employees on the crew are clear of the lines and equipment, (3) ensuring the removal of all protective grounds installed by the crew, (4) reporting this information to the system operator, and (5) releasing the clearance. Only an employee at the worksite can perform these functions.

be tagged to indicate that employees are at work.

This paragraph ensures the disconnection of lines and equipment from their sources of supply and protects employees against the accidental reclosing of the switches. This rule requires the disconnection of known sources of electric energy only. Employers control hazards related to the presence of unexpected energy sources by testing for voltage and grounding the circuit, as required by paragraphs (c)(6) and (c)(7), respectively (see the discussion of these provisions later in this section of the preamble).

OSHA adopted paragraph (c)(2) of the final rule from existing § 1910.269(m)(3)(ii). Existing Subpart V has comparable requirements in § 1926.950(d)(1)(i), (d)(1)(ii)(a), and (d)(1)(ii)(b). The existing provisions require: (1) The employer to identify and isolate the line or equipment from sources of energy (paragraph (d)(1)(i)), and (2) each designated employee in charge to notify and assure the employees on the crew that all disconnecting means have been opened and tagged (paragraphs (d)(1)(ii)(a) and (d)(1)(ii)(b)). OSHA believes that the language in the final rule accurately reflects the steps taken by employers to deenergize lines and equipment. OSHA received no comments on this provision and is adopting it substantially as proposed.

Paragraph (c)(3) of the final rule requires the tagging of automatically and remotely controlled switches. Employers also must render inoperable an automatically or remotely controlled switch if the design of the switch allows for it to be made inoperable. This provision, which OSHA adopted from existing § 1910.269(m)(3)(iii), protects employees from injuries resulting from the automatic operation of such switches. Existing Subpart V contains an equivalent requirement in §§ 1926.950(d)(1)(ii)(b) and (d)(1)(ii)(c). OSHA received no comments on this provision and is adopting it substantially as proposed.

The final rule contains a new exemption from the tagging requirements of final paragraphs (c)(2) and (c)(3) that was not in the proposal. OSHA included this exemption in the final rule as paragraph (c)(4).

Consolidated Edison Company of New York and EEI noted that the compliance directive for existing § 1910.269, CPL 02–01–038, "Enforcement of the Electric Power Generation, Transmission, and Distribution Standard" (June 18, 2003, originally CPL 2–1.38D; hereafter, "CPL 02–01–038") addressed specific conditions under which OSHA considered it a *de minimis* condition to leave network protectors used to isolate network distribution lines from voltage untagged (Exs. 0157, 0227; Tr. 1111–1118). The two organizations requested that the Agency incorporate the directive's language on network protectors into the final rule. Consolidated Edison expressed this view as follows:

> Under normal conditions, switches at the substation are used to deenergize the primary conductors to the distribution transformers. When the primary conductors become deenergized, . . . network protectors operate to disconnect the secondary side of the transformers and to prevent back feed from energizing the primary conductors. The network protectors are automatic devices and are not normally opened or closed manually.
>
> OSHA inserted language into the Compliance Directive and made not tagging a network protector to its associated network transformer for work on the primary feeder . . . a "de minimis" violation if certain conditions were met. . . We are requesting that [an exception for network protectors be included in the standard] and that the "de minimis" violation be eliminated. We recommend the following language be included in the 269 standard:
>
> "Network feeders utilizing low voltage network protectors, or similarly designed devices, are considered isolated from all network sources of supply when the associated feeder is removed from service at the source station and verified as being de-energized, and provided that the design of the protectors prevent operation of the device when the supply feeder is de-energized." [Ex. 0157]

OSHA did not incorporate the recommended exemption into the proposal because the Agency believed that the conditions permitted by the directive were applicable to a single company, Consolidated Edison. OSHA continues to believe that the preferred approach to protect employees is to tag network protectors. However, the Agency's rationale for considering it a *de minimis* condition not to tag network protectors in certain circumstances remains viable. The directive describes the operation of network protectors, the circumstances necessary for a *de minimis* condition, and the Agency's rationale as follows:

> Paragraph (m)(3)(ii) of [existing] § 1910.269 requires 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 to be opened and tagged. Paragraph (m)(3)(iii) requires automatically and remotely controlled switches to be tagged at the point of control.
>
> An AC network system consists of feeders, step-down transformers, automatic reverse-current trip breakers called network protectors, and the network grid of street mains. The network grid is made up of a number of single conductor cables tied together at street intersections to form a solid grid over the area they serve. This grid is typically energized at 120/208 volts from the secondary windings of the distribution transformers serving a particular area.
>
> A network protector, placed between the secondary side of the transformer and the secondary mains, is provided for each transformer. The primary windings of the transformer are connected to a feeder cable that is energized from a substation at voltages ranging from 13 to 33 kilovolts. Each feeder cable is connected to the substation through an automatic circuit breaker. . .
>
> Network protectors are placed between the network transformer and the secondary network to protect against reverse power flow through the network transformer into the supply feeders. Reverse power protection is necessary because fault current would continue to flow into a short circuit in a network transformer or primary feeder. Backfeed from the network grid would continue to flow into the fault even after the primary feeder circuit breaker trips. The other primary feeders would continue to supply power to their network transformers, which are interconnected with the faulted circuit through the network grid.
>
> Under normal conditions, switches at the substation are used to deenergize the primary conductors to the distribution transformers. When the primary conductors become deenergized, the network protectors operate to disconnect the secondary side of the transformers and to prevent backfeed from energizing the primary conductors. The network protectors are automatic devices and are not normally opened or closed manually.
>
> Not tagging a network protector to its associated network transformer for work on the primary feeder is considered a *de minimis* violation of § 1910.269(m)(3)(ii) under the following conditions:
>
> a. The line is deenergized as otherwise required by paragraph (m)(3)(ii);
>
> b. Any switches or disconnecting means (other than network protectors) used to deenergize the line are tagged as required by paragraph (m)(3)(ii);
>
> c. The line is tested to ensure that it is deenergized as required by paragraph (m)(3)(v);
>
> d. Grounds are installed as required by paragraph (m)(3)(vi);
>
> e. The network protectors are maintained so that they will immediately trip open if closed when a primary conductor is deenergized;
>
> f. The network protector cannot be manually placed in a closed position without the use of tools, and any manual override position must be blocked, locked, or otherwise disabled; and
>
> g. The employer has procedures for manually overriding the network protector that incorporates provisions for ensuring that the primary conductors are *energized* before the protector is placed in a closed position and for determining if the line is deenergized for the protection of employees working on the line. [CPL 02–01–038; emphasis included in original]

Figure 12 is a one-line diagram from the directive showing network protectors, the primary conductors (primary voltage feeder), and the extent of the deenergized area for lines connected to the network protectors.

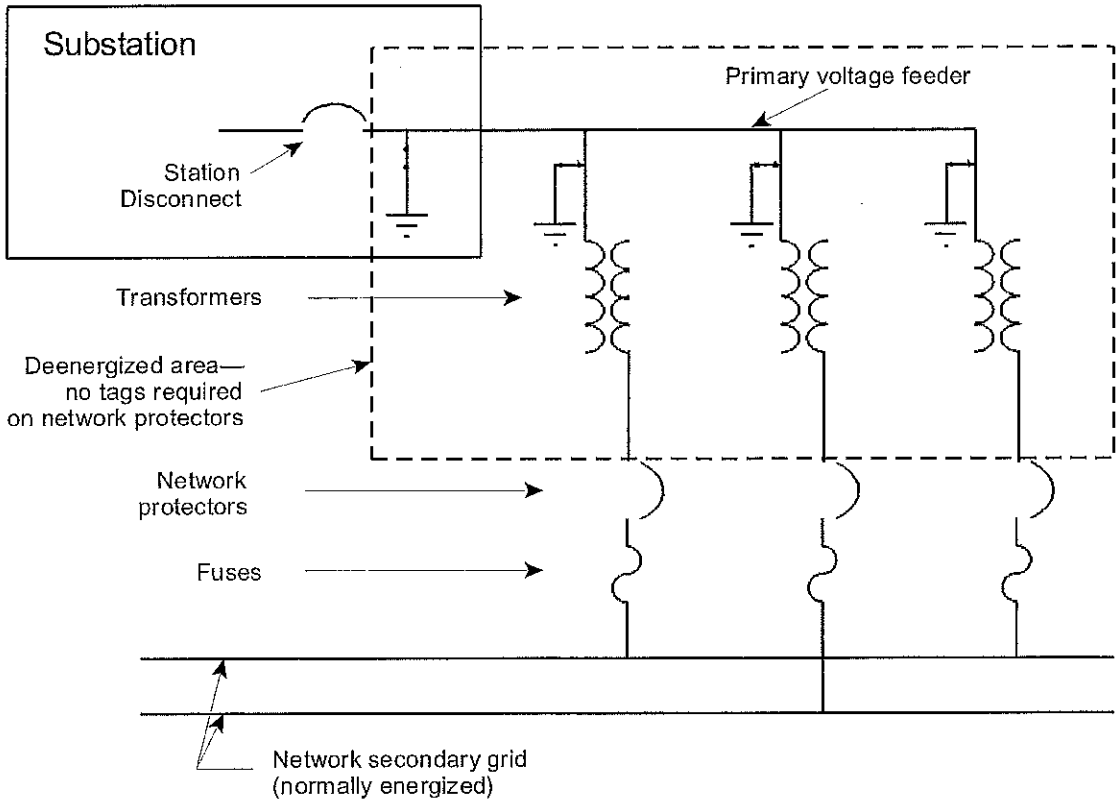

Figure 12 – Network Protectors

OSHA decided to include in the final rule a provision that duplicates the exempted conditions specified in the directive. In issuing the directive, OSHA determined that leaving network protectors untagged under these conditions was a *de minimis* condition, or a condition having "no direct or immediate relationship to safety or health" (29 U.S.C. 658(a)). Moreover, even if Consolidated Edison is the only affected company, it does have a considerable number of circuits and network protectors covered by the conditions listed in the directive: "At Con Edison in any given one-year period over 5,000 feeders involving approximately 123,000 network protectors are worked on using the procedures described [in the directive]" (Ex. 0157). Therefore, the Agency decided to exempt network protectors from the requirements for tags in paragraphs (c)(2) and (c)(3) when the employer can demonstrate that the following conditions are present:

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

2. 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

3. 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: (a) The line connected to the network protector is not deenergized for the protection of any employee working on the line and (b) (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. (See Figure 12 for a depiction of network protectors, the primary conductors (primary voltage feeder), and the extent of the deenergized area for lines connected to the network protectors.)

These three conditions are identical to the last three conditions listed in the § 1910.269 directive. OSHA is not including the first four conditions listed in the directive as provisions in the exemption because other provisions in the final rule already require these conditions. Note that the exemption applies only to the network protectors themselves. As required by paragraphs (c)(2) and (c)(3) in the final rule, employers must still tag any switches or disconnecting means, other than the network protectors, used to deenergize lines or equipment and any other automatically and remotely controlled switches that could cause the opened disconnecting means to close.

OSHA stresses that it is including the network protector exemption in the final rule only for the reasons stated here, that is, because OSHA already concluded that leaving network protectors untagged under the conditions now required by the

exemption is a *de minimis* condition. OSHA does not agree with the other reasons provided by Consolidated Edison and EEI for incorporating the exemption. For example, the Agency does not agree that tagging network protectors would be extremely difficult or complex, as claimed by EEI and Consolidated Edison (Exs. 0157, 0227). The Agency also does not agree with EEI and Consolidated Edison that backfeed from the network grid prevented by network protectors is an unexpected source of electric energy. By design, such backfeed is an expected source of electric energy. If such backfeed were not an expected source, the network protector would not be necessary. Contrary to the claims made by EEI and Consolidated Edison, OSHA made no contradictory statement in the preamble to the 1994 rulemaking on existing § 1910.269 regarding the disconnection of distribution transformers supplying customer loads. In that preamble, OSHA stated only that employers did not have to disconnect transformers if doing so would remove unknown sources of electric energy only (59 FR 4392). OSHA expressly required in the 1994 rulemaking (as in this rulemaking) that employers had to disconnect expected sources of electric energy (*id.*).

In addition, in adopting the network-protector exemption, OSHA decided not to use the language recommended by Consolidated Edison and EEI because their recommended language addresses only the design of network protectors and not the additional procedures required to ensure worker safety when employees perform work on network protectors. OSHA previously concluded, in issuing the directive, that these additional procedures were necessary steps in ensuring employee safety when employers leave network protectors untagged; the Agency reaffirms that conclusion here.

In the notice extending the comment period on the proposal and setting dates for a public hearing, OSHA requested comment on the issue of whether the standard should include tagging requirements for systems using supervisory control and data acquisition (SCADA) equipment (70 FR 59291).[398]

The Agency received only three comments on this issue. One commenter stated, "If OSHA adopts SCADA tagging requirements, it should be as written in the . . . NESC" (Ex. 0201). Two other commenters recommended that OSHA adopt the SCADA requirements in the NESC (Exs. 0212, 0230). One of the commenters, IBEW, voiced its support as follows:

> [The NESC discusses] specific tagging activities utilizing Supervisory Control and Data Acquisition (SCADA) equipment . . . SCADA switching is common place in the electric utility industry for both deenergizing circuits and defeating automatic recloser operation. Both of these actions have a direct impact on employee safety and OSHA should at a minimum reference this section of the NESC [Ex. 0230]

Rule 442E of the 2002 NESC includes the following provision: "When the automatic reclosing feature of a reclosing device is disabled during the course of work on *energized* equipment or circuits, a tag shall be placed at the reclosing device location" (Ex. 0077; emphasis added).[399] The SCADA provisions in that consensus standard are in the form of an exception to this tagging requirement (*id.*). Final § 1926.961 does not contain a similar requirement for tagging reclosing devices, as § 1926.961 applies to deenergizing lines and equipment, and not to work on energized lines and equipment. However, final Subpart V provides requirements for disabling reclosing in paragraphs (b)(3) and (c)(4) of § 1926.964. In addition, employers may need to disable automatic circuit reclosing as one measure in ensuring that the maximum transient overvoltage does not exceed a specific value, as required by the minimum approach-distance provisions of § 1926.960(c)(1) and Table V–2. To disable automatic reclosing devices, the employer will need to adopt measures that prevent reenabling the automatic feature of these devices in addition to turning the feature off. When the employer uses SCADA on a reclosing device, the employer may follow the SCADA provisions in the NESC to ensure that the reclosing feature remains disabled. However, the Agency believes that there are other methods, such as tagging those controls, that employers can use for the same purpose. Therefore, OSHA is not adopting the SCADA rules from the 2002 NESC.

Paragraph (c)(5) of the final rule, which OSHA is adopting without change from proposed paragraph (c)(4), requires that tags attached to disconnecting means prohibit operation of the disconnecting means and state that employees are at work. OSHA adopted this requirement from existing § 1910.269(m)(3)(iv). Existing § 1926.950(d)(1)(ii)(b) specifies that tags indicate that employees are working; however, it does not require that the tags prohibit operation of the disconnecting means. The Agency believes that it is essential for the tags to contain this prohibition so that the meaning of the tag is clear.

Proposed paragraph (c)(5) would have required employers to test the lines or equipment. This test would ensure that the lines or equipment are deenergized and prevent accidents resulting from someone's opening the wrong disconnect. It also would protect employees from hazards associated with unknown sources of electric energy.

OSHA based proposed paragraph (c)(5) on existing § 1910.269(m)(3)(v). Existing § 1926.950(d)(1)(iii) requires the employer to perform a test or a visual inspection to ensure that the lines or equipment are deenergized. Employers cannot determine that a line or equipment is deenergized by visual inspections alone because voltage backfeed, induced current, and leakage current can energize electric lines and equipment without the employee "seeing" it (Ex. 0041). Additionally, OSHA determined in the 1994 § 1910.269 rulemaking that visual inspection instead of testing was not sufficient for this purpose because of evidence about lack of testing causing accidents (59 FR 4393; 269-Exs. 3–107, 9–2, 12–12). Therefore, OSHA proposed to require a test, rather than a visual inspection, to determine whether the lines or equipment are energized. OSHA adopts that requirement in the final rule as final paragraph (c)(6).

In the proposed rule, OSHA did not specify the type of test; however, the preamble to the proposal stated that the Agency expects employers to use testing procedures that will indicate reliably whether the part in question is energized (70 FR 34872). OSHA stated in the preamble to the proposal that using a voltage detector on the part would be acceptable for this purpose (*id.*). OSHA requested comments on when and if methods such as "fuzzing" a line are acceptable. The preamble to the proposal explained that "fuzzing," or "buzzing," a line involves using a live-line tool to hold a wrench or similar tool near a line and listening for the buzzing sound emitted as the tool approaches a circuit part energized at a high voltage (*id.*). OSHA requested comments on this issue because two OSHA letters of interpretation, which addressed a similar requirement in existing § 1910.269(n)(5), recognized the fuzzing or buzzing method of checking lines for voltage. (See the August 23, 1995, letter to Mr. Enoch F. Nicewarner

[398] SCADA is a computer system for monitoring and controlling equipment (in this case, electric power transmission and distribution lines and equipment).

[399] The relevant provisions in the 2012 edition of the NESC are identical.

and the October 18, 1995, letter to Mr. Lonnie Bell.[400])

OSHA decided that fuzzing, or buzzing, will not be an acceptable testing method under the final rule. The preamble to the proposal noted that this method has obvious disadvantages when ambient noise levels are excessive and is only reliable above certain voltage levels (70 FR 34872; see also 269-Ex. 8–5). Moreover, rulemaking participants universally opposed recognizing the fuzzing method of checking lines for voltage. (See, for example, Exs. 0155, 0162, 0175, 0213, 0220, 0227, 0230; Tr. 882–884, 1238.) Several rulemaking participants reported incidents involving failure to detect voltage using this method (Exs. 0213, 0220; Tr. 947–948). Some commenters recommended requiring devices specifically designed as voltage detectors (Exs. 0186, 0213, 0230; Tr. 1238).

To implement its decision, OSHA modified the language of the requirement proposed in paragraph (c)(5) so that employers must perform the test "with a device designed to detect voltage." Such devices include voltage detectors meeting ASTM F1796–09 *Standard Specification for High Voltage Detectors—Part 1 Capacitive Type to be Used for Voltages Exceeding 600 Volts AC* (Ex. 0480).[401] OSHA is adopting this requirement in paragraph (c)(6) in the final rule. The final rule also replaces the proposed term "employee in charge of the work" with "employee in charge" for consistency with the rest of final paragraph (c). The designated employee in charge of the clearance need not be a supervisor or be responsible for the work. The employee in charge need only be responsible for the clearance.

Final paragraph (c)(7), which OSHA is adopting without substantive change from proposed paragraph (c)(6), requires the installation of any protective grounds required by § 1926.962. Installation of protective grounds must occur after employees deenergize and test the lines or equipment in accordance with the previous provisions; at this point, it is safe to install a protective ground. OSHA based this requirement on existing § 1910.269(m)(3)(vi). Paragraph (d)(1)(iv) of existing § 1926.950 contains an equivalent requirement.

Mr. Brian Erga with ESCI recommended that OSHA reword this provision to refer to "temporary protective grounding equipment" rather than "protective grounds" (Ex. 0155). He noted that his recommendation is consistent with the terminology used in ASTM F855, *Standard Specifications for Temporary Protective Grounds to Be Used on De-energized Electric Power Lines and Equipment.* He made the same recommendation with respect to other provisions of the proposal, such as proposed § 1926.962(c).

OSHA decided not to use the term recommended by Mr. Erga. ASTM F855–04 covers "the equipment making up the temporary grounding system used on de-energized electric power lines, electric supply stations, and equipment" (Ex. 0054).[402] The term "protective grounds," as used in final Subpart V and § 1910.269, encompasses more than just the equipment covered by the ASTM standard. For instance, employers can use permanent (that is, fixed) grounding equipment as part of a protective grounding system. Moreover, the protective grounding system also includes the "ground" itself, that is, the device to which employees attach the grounding equipment to bring deenergized parts to ground potential. Therefore, OSHA is adopting the language in the proposal.

After an employer follows the seven previous provisions of final paragraph (c), final paragraph (c)(8) permits the lines or equipment to be treated as deenergized. OSHA based this provision, which OSHA is adopting without substantive change from proposed paragraph (c)(7) and which has no counterpart in existing Subpart V, on existing § 1910.269(m)(3)(vii).[403]

Mr. Erga also commented on this provision in the proposed rule, recommending that the standard use the term "deenergized and grounded" rather than just "deenergized" (Ex. 0155). He maintained that "line[s] and equipment [are] not safe to work unless [they have] been de-energized and grounded" (*id.*).

OSHA decided not to adopt Mr. Erga's recommendation. The final rule, as with existing § 1910.269, does not always require grounding of deenergized equipment. Final paragraph (b) of § 1926.962 permits deenergized lines and equipment to remain ungrounded under limited circumstances. OSHA believes that it is safe to work on deenergized lines and equipment under these limited circumstances, and there is no evidence in this rulemaking record that indicates that it would not be reasonably safe to do so. Therefore, OSHA is adopting the language of this provision as proposed.

In some cases, as when an employee in charge has to leave the job because of illness, it may be necessary to transfer a clearance. Under such conditions, final paragraph (c)(9), which OSHA is adopting from proposed paragraph (c)(8), requires the employee in charge to inform the system operator and the employees in the crew of the transfer. If the employee holding the clearance must leave the worksite due to illness or other emergency, the employee's supervisor could inform the system operator and crew members of the transfer in clearance. This requirement, which OSHA based on existing § 1910.269(m)(3)(ix), has no counterpart in existing Subpart V.

The Agency received no comments on this provision in the proposal. However, neither the existing standard at § 1910.269(m)(3)(ix) nor the proposal addresses who notifies crew members of the transfer in clearance. Because the employee in charge of the clearance is responsible for the clearance and communications regarding it, the notification must come from that individual. Therefore, OSHA has revised the language of paragraph (c)(9) in the final rule to clarify that "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 . . . employees in the crew " of the transfer.

After transfer of the clearance, the new employee in charge is responsible for the clearance. To avoid confusion that could endanger the entire crew, employers must ensure that only one employee at a time be responsible for any clearance.

Once the crew completes its work, the employee in charge must release the clearance before the system operator can reenergize the lines or equipment. Paragraph (c)(10) covers this procedure.

[400] The Nicewarner letter is available at *http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=21897.* The Bell letter is available at *http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=21981.* (After the effective date of the final rule, the Nicewarner letter will not be available on the Internet, and OSHA will edit the Bell letter to remove the response to the question on fuzzing.)

[401] ASTM F1796–09 is an updated version of ASTM F1796–97 (2002), which IBEW cited in Ex. 0480. OSHA reviewed both documents and determined that devices meeting either ASTM standard are acceptable for use in meeting paragraph (c)(6) of the final rule.

[402] The most recent edition of that consensus standard, ASTM F855–09, uses identical language to describe its scope.

[403] As noted earlier in this preamble, under the summary and explanation for final § 1926.960(b)(2), existing § 1926.950(b)(2) requires electric equipment and lines to be considered as energized until determined to be deenergized by tests or other appropriate means. The existing rule is insufficient to protect employees because employers cannot rely on a simple test for a deenergized condition to ensure that lines and equipment remain deenergized. OSHA concludes that final § 1926.961 contains the appropriate procedures for treating lines and equipment as deenergized.

To ensure that it is safe to release the clearance, the employee in charge must: (1) Notify workers in the crew [404] of the release, (2) ensure that they are clear of the lines and equipment, (3) ensure the removal of all protective grounds, and (4) notify the system operator of the release of the clearance. OSHA based this provision on existing § 1910.269(m)(3)(x). Paragraph (d)(1)(vii) of existing § 1926.950 contains an equivalent requirement. OSHA received no comments on this provision, proposed as paragraph (c)(9), and is adopting it substantially as proposed. Paragraph (c)(7) requires the employer to ensure the installation of protective grounds for the crew, but does not require the crew to install them. To account for the possibility that the crew does not install the grounds protecting them, paragraph (c)(10)(iii) requires the employee in charge to ensure the removal of "protective grounds protecting employees under [the] clearance" rather than "protective grounds installed by the crew."

Final paragraph (c)(11), which OSHA is adopting without substantive change from proposed paragraph (c)(10), requires the individual who is releasing the clearance to be the one who requested it, unless the employer transfers responsibility under final paragraph (c)(9). Final paragraph (c)(11) ensures that the employee in charge of the clearance authorizes release of the clearance. OSHA based this paragraph, which has no counterpart in existing Subpart V, on existing § 1910.269(m)(3)(xi). The Agency received no comments on this provision.

Paragraph (c)(12), proposed as paragraph (c)(11), prohibits the removal of a tag without release of its associated clearance. Because the persons who place and remove the tags may not be the same person, the standard prohibits removing a tag unless the employee in charge of the associated clearance first releases it. OSHA based this provision, which has no counterpart in existing Subpart V, on existing § 1910.269(m)(3)(xii). OSHA is adopting paragraph (c)(12) with one clarification from proposed paragraph (c)(11). Final paragraph (c)(12) clarifies that the release of the clearance must comply with final paragraph (c)(11), in addition to final paragraph (c)(10) (which corresponds to proposed paragraph (c)(9), the only provision referenced in proposed paragraph (c)(11)). As noted in the preceding paragraph of this preamble, paragraph (c)(11) of the final rule requires the individual who is releasing the clearance to be the one who requested it, unless the employer transfers responsibility. This provision applies regardless of whether final paragraph (c)(12) references it, and the final rule makes its application clear.

NIOSH recommended that the person removing the tag "be the person who placed the tag on the line or the supervisor, unless they have been replaced due to shift change" (Ex. 0130). NIOSH recommended that, if a shift change occurred, the employer brief the replacement workers on their responsibilities (*id.*).

OSHA agrees with NIOSH that employees placing and removing tags need appropriate training. In this regard, § 1926.950(b)(1) requires that each employee receive training in, and be familiar with, the safety-related work practices, safety procedures, and other safety requirements in Subpart V that pertain to his or her job assignments. However, OSHA does not believe that the employee who removes a tag under paragraph (c)(12) needs to be the same one who placed it. Because tags are often remote from the work location, the employee in charge of the clearance does not typically place or remove them. The key to employee safety in such cases is that no one may remove a tag until the employee in charge of the associated clearance releases that clearance. Accordingly, the key employee in this situation is the employee in charge of the clearance (that is, the employee who requested the clearance or the employee to whom the employer has transferred responsibility under final paragraph (c)(9)). Therefore, OSHA is not adopting NIOSH's recommendation.

According to final paragraph (c)(13), 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. This provision protects employees from possible reenergization of the line or equipment while employees are still at work. This provision does not require the removal of all tags from all disconnecting means before any of them may be reclosed. Instead, it requires that all tags for any particular switch be removed before that switch is closed. It is important in a tagging system not to return any energy isolating device to a position that could allow energy flow if there are any tags on the energy isolating device that are protecting employees. For example, after the employee in charge releases the clearance for a 5-mile section of line that the employer deenergized by opening switches at both ends of the line, the employer can close any one switch only after all the tags are removed from that switch. OSHA received no comments on this provision (proposed as paragraph (c)(12)) and is adopting it substantially as proposed. Final paragraph (c)(13), which has no counterpart in Subpart V, has been taken from existing § 1910.269(m)(3)(xiii).

13. Section 1926.962, Grounding for the Protection of Employees

Sometimes, deenergized lines and equipment become energized. Such energization can happen in several ways, for example, by contact with another energized circuit, voltage backfeed from a customer's cogeneration installation, lightning contact, or failure of the clearance system outlined in final § 1926.961.

Electric utilities normally install transmission and distribution lines and equipment outdoors, where the weather and actions taken by members of the general public can damage the lines and equipment. Electric utilities install many utility poles alongside roadways where motor vehicles can strike the poles. Falling trees damage distribution lines, and the public may use transmission-line insulators for target practice. Additionally, customers fed by a utility company's distribution line may have cogeneration or backup generation capability, sometimes without the utility company's knowledge. All of these factors can reenergize a deenergized transmission or distribution line or equipment. When energized lines are knocked down, they can fall onto deenergized lines. A backup generator or a cogenerator can cause voltage backfeed on a deenergized power line. Lastly, lightning, even miles from the worksite, can reenergize a line. All of these situations pose hazards to

[404] The employees in the crew are working under the clearance assigned to the employee in charge of the clearance. The proposed rule required notification of "each employee under his or her direction." The final rule, in paragraph (c)(10)(i), uses the phrase "under that clearance" instead of "under his or her direction" to make it clear that the employee in charge is responsible for the clearance and, as noted earlier in this section of the preamble, need not be a foreman or supervisor. In addition, the final rule uses the term "employees under that clearance" in place of the proposed terms "employees in the crew" and "the crew" in paragraphs (c)(10)(ii) and (c)(10)(iii), respectively. This revision makes it clear that, in cases in which a single employee is in charge of the clearance for multiple crews under paragraph (b)(4)(i), the employee in charge must ensure that employees in all crews under his or her clearance are clear of lines and equipment and that grounds protecting employees in all crews under his or her clearance are removed.

employees working on deenergized transmission and distribution lines and equipment. These circumstances factored into 14 of the accidents described in 269-Exhibit 9–2, as noted in the preamble to the 1994 final rule adopting § 1910.269 (59 FR 4394).

Grounding the lines and equipment protects employees from injury should such energizing occur. Grounding also protects against induced current and static charges on a line.[405] (These induced and static voltages can be high enough to endanger employees, either directly from electric shock or indirectly from involuntary reaction (Exs. 0041, 0046.)

Grounding, as a temporary protective measure, involves connecting the deenergized lines and equipment to earth through conductors. As long as the conductors remain deenergized, this action maintains the lines and equipment at the same potential as the earth. However, if a source impresses voltage on a line, the voltage on the grounded line rises to a value dependent upon the impressed voltage, the impedance between its source and the grounding point, and the impedance of the grounding conductor.

Employers use various techniques to limit the voltage across an employee working on a grounded line should the line become energized. Bonding is one of these techniques; it involves bonding conductive objects within the reach of the employee to establish an equipotential work area for the employee. Bonding limits voltage differences within this area of equal potential to a safe value.

OSHA took the requirements proposed in § 1926.962 from existing § 1910.269(n). Existing § 1926.954 contains provisions related to grounding for the protection of employees. In developing the proposal for this rulemaking, OSHA reviewed existing § 1926.954 and found that it is not as protective as existing § 1910.269(n) and also contains redundant and unnecessary requirements. For example, as noted under the summary and explanation of § 1926.960(b)(2) of this final rule, existing § 1926.950(b)(2) requires "[e]lectric equipment and lines [to] be considered energized until determined to be deenergized by tests or other appropriate methods or means." Existing § 1926.954(a) similarly requires "[a]ll conductors and equipment [to] be treated as energized until tested or otherwise determined to be deenergized or until grounded." These provisions do not adequately protect employees from inadvertently reenergized lines and equipment, however. As noted in the earlier discussion, electric power transmission and distribution lines and equipment can become reenergized even after an employer deenergizes them. Therefore, OSHA concluded in the § 1910.269 rulemaking that grounding deenergized lines and equipment is essential, except under limited circumstances (59 FR 4394–4395). The Agency is adopting that approach here. In developing § 1926.962 of the final rule, OSHA eliminated redundant requirements from existing § 1926.954, consolidated related requirements from that section, and strengthened the current Subpart V requirements to protect employees better.

Section 1926.962 of the final rule addresses protective grounding and bonding.[406] Paragraph (a) provides that all of § 1926.962 applies to the grounding of transmission and distribution lines and equipment for the purpose of protecting employees. Paragraph (a) also provides that paragraph (d) in final § 1926.962 additionally applies to the protective grounding of other equipment, such as aerial lift trucks, as required elsewhere in Subpart V. Under normal conditions, such mechanical equipment would not be connected to a source of electric energy. However, to protect employees in case of accidental contact of the equipment with live parts, OSHA requires protective grounding elsewhere in the standard (in § 1926.964(c)(11), for example); to ensure the adequacy of this grounding, paragraph (d) of final § 1926.962 addresses the ampacity and impedance of protective grounding equipment. A note following paragraph (a) indicates that § 1926.962 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. Although the Agency did not propose the note, OSHA included the note in the final rule to clarify that § 1926.962 applies both when Subpart V requires grounding of transmission and distribution lines and equipment[407] and when the employer grounds such lines and equipment for the protection of employees even though not required to do so.

Mr. James Junga with Local 223 of the Utility Workers Union of America suggested that any requirement in the rule "that an aerial lift truck should be grounded should be worded exactly that way, not implied" (Ex. 0197). He stated that this language would eliminate any confusion between a worker and his or her supervisor regarding this issue (*id.*).

The Agency notes that § 1926.962 in the final rule does not contain requirements for grounding aerial lifts or other types of mechanical equipment. Final §§ 1926.959(d)(3)(iii) and 1926.964(c)(11) contain requirements to ground this equipment. These provisions, which do permit alternatives to grounding mechanical equipment, specify precisely when employers must ensure proper grounding of this equipment.

TVA recommended that § 1926.962 also apply to medium-voltage installations in generating plants, explaining:

> The "application" sections of 1910.269(n) and 1926.961 are limited to the grounding of transmission and distribution lines and equipment for the purpose of protecting employees. Both 1910.269 and Subpart V have no requirements on grounding of generating plant conductors and equipment for the protection of employees. We believe this exposes employees to shock and electrocution hazards in the workplace. These conductors may become energized by dangerous induced voltage and failure of the clearance system. For circuits operating at 480 V and below, we recommend grounding for the protection of employees from the hazard of induced voltage because the ampacity of the grounding jumper necessary to conduct the current for the time to clear the fault would make the jumper [too] large to install in many cases. It is recommended that the final rule incorporate requirements for grounding medium voltage (1 kV to 23 kV) conductors and equipment in generating plants. [Ex. 0213]

[405] Induced current can flow in a deenergized conductor when a nearby conductor is carrying alternating current. The varying electromagnetic field that surrounds the current-carrying conductor causes electrons to flow in any nearby electrical path, or loop, formed by a nearby deenergized conductor. The amount of current in the loop increases with an increase in the length of the loop that intersects the electromagnetic field; that is, the current increases as the length of the deenergized conductor running in parallel with a current-carrying conductor increases.

Induced static electric charge can develop on a conductive object in several ways. The capacitive coupling that occurs between an energized conductor and a nearby deenergized conductive object can induce a voltage on the conductive object. Similarly, the same environmental conditions that can cause an electric charge to build in clouds can cause a buildup of charge on a deenergized conductor. A static discharge in the form of lightning can deposit an electric charge directly on the conductive object.

[406] As used throughout the rest of this discussion and within final § 1926.962, the term "grounding" includes bonding. Technically, grounding refers to the connection of a conductive part to ground, whereas bonding refers to connecting conductive parts to each other. However, for convenience, OSHA is using the term "grounding" to refer to both techniques of minimizing voltages to which an employee will be exposed.

[407] For example, final Subpart V requires the employer to ground transmission and distribution lines and equipment in §§ 1926.962(b) and 1926.964(b)(4).

Subpart V does not apply to work on generation installations. Therefore, it would be inappropriate to include grounding requirements for generating plants in Subpart V. Although final § 1910.269 applies to work in generation plants, the grounding requirements in § 1910.269(n) do not apply to electric power generation circuits. Existing § 1910.269(n)(1) provides that § 1910.269(n) applies to "the grounding of transmission and distribution lines and equipment for the purpose of protecting employees." Existing § 1910.269(n)(2) requires such lines and equipment to be grounded under certain conditions. The remaining requirements in existing § 1910.269(n) apply to grounding of transmission and distribution lines and equipment without regard to whether § 1910.269 requires them to be grounded if the grounding is "for the purpose of protecting employees."

To respond to TVA's comment, OSHA examined two issues: (1) Whether final § 1910.269(n)(2) should require grounding of electric power generation circuits, and (2) whether the other requirements in final § 1910.269(n) should apply to the grounding of generation circuits whenever an employer grounds them to protect employees (that is, even when the standard does not require such grounding). With respect to the first issue, OSHA does not believe that it is always necessary to ground electric power generation circuits. These circuits are similar in most respects to electric utilization circuits (circuits used to supply equipment that uses electric energy for lighting, heating, or other purposes) covered by Subpart S; Subpart S, which generally applies to utilization circuits in generation plants, does not require grounding of deenergized circuits. Subpart S rather than § 1910.269 covers many of the circuits in generation plants.[408] The voltages on generation circuits are typically lower than distribution and transmission voltages. In addition, the hazards of induced voltage, and voltages impressed on the circuits from lightning or contact with other energized lines, noted earlier as being common to transmission and distribution lines, are rarely, if ever, present on generation circuits. Therefore, OSHA concludes that it is unnecessary to require grounding of electric power generation lines and equipment in final § 1910.269(n)(2).

Note, however, that electric power generation plants typically have the electrical output of the generators feeding a substation. The generating plant substation, in turn, steps up the voltage and supplies a transmission line. Consequently, any lines and equipment in a substation at a generation plant connected to a transmission line are subject to the same induced and impressed voltage hazards as the transmission line. OSHA expects employers to treat lines and equipment connected to a transmission line as transmission lines and equipment for purposes of final §§ 1926.962 and 1910.269(n).[409] This requirement will protect employees from the hazards of induced and impressed voltage that may be present at electric generation plants.

With respect to the second issue, OSHA agrees with TVA that grounding of electric power generation circuits should comply with the grounding requirements in final § 1910.269(n) other than paragraph (n)(2). These requirements serve two functions. First they protect employees working on grounded circuits from electric shock should the circuits become energized. Second, they protect employees from hazards related to the installation and removal of protective grounds and to the ability of the ground to carry current. For example, final paragraphs (n)(6)(i) and (n)(6)(ii) ensure that employees are not injured if the protective grounding equipment is installed on or removed from an energized circuit. Also, paragraph (n)(4) ensures that the protective grounding equipment can safely carry the current that would flow if the circuit becomes energized. Applying these provisions to electric power generation circuits will protect employees from these hazards. Therefore, OSHA decided to apply the requirements of final § 1910.269(n), other than paragraph (n)(2), to electric generation lines and equipment.

Paragraph (b) of final § 1926.962 sets the conditions under which employers must ensure that lines and equipment are grounded as a prerequisite to employees' working the lines or equipment as deenergized.[410] Generally, for lines or equipment to be treated as deenergized, employers must deenergize the lines and equipment as specified under § 1926.961 and then ground them as well. An employer may omit grounds on lines and equipment by demonstrating that either installation of a ground is impracticable (such as during the initial stages of work on underground cables, when the conductor is not bare for grounding) or the conditions resulting from the installation of a ground would present greater hazards than work without grounds. OSHA expects that conditions warranting the absence of protective grounds will be rare.

When paragraph (b) does not require grounds, but the lines and equipment are to be treated as deenergized, the employer must meet certain conditions and ensure that employees use additional precautions. The employer must still deenergize the lines and equipment according to the procedures required by final § 1926.961 (per final paragraph (b)(1)). Also, there must be no possibility of contact with another energized source (per final paragraph (b)(2)) and no hazard of induced voltage

[408] The safety-related work practices required by §§ 1910.331 through 1910.335 in Subpart S apply to utilization circuits in electric power generation plants that "are not an integral part of a generating installation." (See Note 1 to § 1910.331(c)(1).)

[409] The existing directive for § 1910.269, CPL 02–01–038, generally permits employers to designate where in a generation plant substation the generation installation ends and the transmission installation begins for the purpose of choosing to follow § 1910.269(d) or (m) in deenergizing that portion of the substation. Employers must deenergize circuits on the generation side of the demarcation point in accordance with § 1910.269(d) and the remaining circuits in the substation in accordance with § 1910.269(m). However, irrespective of any such demarcation, § 1910.269(n) always applies to any lines or equipment still connected to the transmission circuit after the employer deenergizes the circuit.

[410] As previously noted, existing § 1926.954(a) requires conductors and equipment to be considered as energized until determined to be deenergized or until grounded. Paragraph (c) of existing § 1926.954 requires bare communication conductors on poles or structures to be treated as energized unless protected by insulating materials. Paragraph (b)(2) of final § 1926.960 covers the hazard addressed by these existing requirements, as discussed earlier in this preamble.

Existing § 1926.954(b) addresses when to ground new lines and equipment. When an employee installs equipment, it poses the same hazard to the employee as any other conductive object manipulated near exposed energized parts. Requirements contained in final § 1926.960(c) and (d) adequately address this hazard. The installation of lines, however, poses additional hazards. First, the lines may be subject to hazardous induced voltage. Second, because of their length, new overhead lines are much more likely than other new equipment to contact existing energized lines. This contact can happen, for example, through failure of the stringing and tensioning equipment used to install the new lines or through failure of the existing lines or support structures. Final § 1926.964(b) addresses these hazards by specifically covering the installation and removal of overhead lines. Lastly, new underground lines, which are run as insulated cable, do not pose these electrical hazards.

For these reasons, OSHA indicated in the preamble to the proposal that the Agency would not include the provisions of existing § 1926.954(b) in the final rule (70 FR 34873). However, OSHA requested comment on whether the proposal adequately protected employees from hazards associated with the installation of new lines and equipment. Only one commenter supported including the existing requirements in the final rule, but that commenter did not provide any rationale for its position (Ex. 0175). Therefore, OSHA is not including the provisions of existing § 1926.954(b) in the final rule.

present (per final paragraph (b)(3)). Since these precautions and conditions do not protect against the possible reenergizing of the lines or equipment under all conditions, the standard requires employers to ground lines and equipment in all but extremely limited circumstances.

Paragraph (f) of existing § 1926.954 allows employers to omit grounds without the additional restrictions specified in final § 1926.962(b)(1) through (b)(3). However, the existing standard requires the lines or equipment to be treated as energized in such cases. While the final rule does not specifically permit omitting grounds for conductors that are treated as energized, it does not require grounding unless the equipment is to be considered as deenergized. (See also the discussion of final § 1926.960(b)(2), earlier in this section of the preamble.)

Ms. Salud Layton with the Virginia, Maryland & Delaware Association of Electric Cooperatives opposed requiring the grounding of lines operating at 600 volts and less:

> We do not agree with [the requirement to ground lines operating at 600 volts or less] and do not see how this is physically possible in most cases. We typically open, isolate, [tagout], and test 600 volt lines deenergized prior to performing work. We do not see the need for protective grounding in order to provide safety to employees on these circuits. Further, operational methods do not exist to ground 600 volt URD (underground residential distribution) or insulated overhead circuits.
>
> Commercial electricians commonly work on 600 volt or less lines and there is no industry standard from electricians or utilities to ever ground such lines. The industry standard is to isolate, test, and tag. This should be sufficient for personnel safety. It should be noted that most 600 volt or less equipment has no provisions or space for attaching protective grounds. [Ex. 0175]

OSHA believes that the operating voltage on a distribution line is immaterial. As explained earlier, these lines can not only become energized by a failure of the clearance system, but also by a number of external factors that the deenergizing procedures required by final § 1926.961 do not control. These factors include lightning, voltage backfeed, and contact with other energized lines. Commercial electricians working on systems operating at 600 volts or less do not face these same hazards unless they are working on a distribution line; in such cases, § 1910.269 or Subpart V, which require grounding the lines and equipment, would cover the electricians. Thus, OSHA concludes that, regardless of voltage, it is necessary to ground transmission and distribution lines and equipment that are to be treated as deenergized, except when those external hazards are not present.

Ms. Layton did not convince the Agency that it is impossible to ground lines operating at 600 volts or less. Ms. Layton did not state why it is not possible to ground these lines. Protective grounding equipment is available in sizes down to No. 2 AWG, and this size should be suitable for typical line conductor sizes at the 600-volt class (269 Ex. 8–5; Ex. 0054). Moreover, even if grounding were not possible, it would be possible, and acceptable under the final rule, to work the lines as though energized.

Mr. Wilson Yancey with Quanta Services recommended that OSHA remove the exceptions for installing grounds (Exs. 0169, 0234). He commented that the exceptions are subject to possible abuse by workers, explaining, "Since it is easier not to ground, crews might attempt to claim that the specified criteria for not grounding applies in their situation" (Ex. 0234). He suggested that employees should always work lines and equipment as though energized if grounds cannot be provided (*id.*).

As noted earlier, OSHA believes that the conditions in which the final rule will not require grounding are extremely rare. OSHA also believes that the restrictions imposed by final § 1926.962(b) reduce the risk of electric shock to employees to an acceptable level. The alternative suggested by Mr. Yancey seems compelling; however, it relies on the assumption that working lines and equipment energized is as safe as, or safer than, working them deenergized without grounds in the limited conditions permitted under this final rule. OSHA concludes that when the risk of electric shock is low, as it is under conditions that satisfy final § 1926.962(b)(1) through (b)(3), working the lines and equipment energized poses more risk than working them deenergized without grounds. The choice suggested by Mr. Yancey would provide an incentive to work with the lines and equipment energized (rather than deenergized, but treated as energized), which the Agency believes is less safe. Therefore, OSHA is adopting paragraph (b) without substantive change from the proposal.

Paragraph (f) of existing § 1926.954 addresses where employers must place grounds. The existing standard requires employers to place grounds between the work location and all sources of energy and as close as practicable to the work location. Alternatively, employers can place grounds at the work location. If employees are to perform work at more than one location in a line section, the existing standard requires them to ground and short circuit the line section at one location and to ground the conductor they are working on at each work location. Although these requirements are designed to protect employees in case the line on which they are working becomes reenergized, OSHA indicated in the preamble to the proposal that it did not believe that these existing provisions ensure the use of grounding practices and equipment that are adequate to provide this protection (70 FR 34874).

OSHA proposed requirements similar to the requirements in existing § 1926.954(f) when it initially proposed § 1910.269(n). In developing final § 1910.269(n), OSHA reviewed the accidents in 269-Ex. 9–2 and 269-Ex. 9–2A for situations involving improper protective grounding. There were nine accidents in these two exhibits related to protective grounding. In three cases, inadequately protective grounds, which did not protect the employee against hazardous differences in potential, were present. Because grounding is a backup measure that provides protection only when all other safety-related work practices fail, OSHA concluded that this incidence of faulty grounding was significant.

In promulgating § 1910.269 in 1994, OSHA concluded that grounding practices that do not provide an equipotential zone (which safeguards an employee from voltage differences) do not provide complete protection (59 FR 4395–4396). In case the line becomes energized inadvertently, the voltages could be lethal, as demonstrated by some of the exhibits in the § 1910.269 rulemaking record (269-Exs. 6–27, 57). Absent equipotential grounding, the only protection an employee will receive is if he or she does not contact the line until a circuit protective device clears the energy source, thereby removing the potentially lethal voltage on the line.

For these reasons, OSHA proposed in this rulemaking to require grounds that would protect employees in the event that the line or equipment on which they are working becomes reenergized. OSHA took proposed § 1926.962(c) directly from existing § 1910.269(n)(3), which provides that protective grounds must be so located and arranged that employees are not exposed to hazardous differences in electric potential. The Agency designed the proposal to allow employers and employees to use any grounding method that protects employees in this way. OSHA explained in the preamble to the proposal that, for employees working at elevated positions

on poles and towers, single-point grounding may be necessary, together with grounding straps, to provide an equipotential zone for the worker (70 FR 34874). OSHA also noted in the proposal that grounding at convenient points on both sides of the work area might protect employees in insulated aerial lifts working midspan between two conductor-supporting structures (*id.*). Bonding the aerial lift to the grounded conductor would ensure that the employee remains at the potential of the conductor in case of a fault. The Agency also explained that other methods may be necessary to protect workers on the ground, including grounding mats and insulating platforms (*id.*). In the preamble to the proposal, the Agency stated that it believed that the proposed performance-oriented approach to grounding would provide flexibility for employers, while still affording adequate protection to employees (*id.*).

Ms. Salud Layton with the Virginia, Maryland & Delaware Association of Electric Cooperatives argued that the requirement to provide an equipotential zone is unnecessary:

> [W]e agree with the need to employ safe grounding practices. However, we have concerns with the requirement for equipotential grounding as the "safe" method for grounding when an employee is working on the pole. Three incidents/injuries are referenced that were a result of inadequate grounding. More information is needed to determine the inadequacies with these grounds. That is, were there high resistant ground connections, were the grounds placed as described in 1926.954 (b), and were the grounds properly constructed to provide maximum protection to the employee[.] [Ex. 0175]

Ms. Layton recognized the importance of "grounds properly constructed to provide maximum protection to the employee" (*id.*). The accidents described in the 1994 rulemaking clearly indicate that the grounds involved did not provide a working zone free of hazardous differences in electric potential. As noted earlier, evidence in that record also indicated that lethal voltages can develop when employees use such inadequate grounds.

In its posthearing brief, EEI maintained that existing § 1910.269(n), and the identically worded proposed § 1926.962(c), are unenforceably vague (Ex. 0501). EEI argued as follows:

> [T]he proposed standards would require employers to place grounds in such a manner "as to prevent each employee from being exposed to hazardous differences in electrical potential." See proposed 1926.962(c). OSHA doubtless would characterize this as a "performance" standard that allows the employer to cho[o]se a means of compliance. But there is a point at which the total absence of objective criteria for achieving compliance takes a standard beyond the legally safe harbor of a "performance standard" to the constitutionally infirm area of ambiguity and vagueness. That is where a requirement for "equipotential grounding" stands as of now.
>
> First, the record allows no other conclusion. Mr. Tomaseski and Mr. Brian Erga, who together are as knowledgeable as any in the electric utility industry about transmission and distribution grounding, agree that there are no guidelines, standards or other sources to guide employers as to how to achieve equipotential grounding (Tr. 1262–1266). Mr. Erga commented in particular that IEEE 1048 is "quite outdated." (Tr. 1262).
>
> Second, OSHA's enforcement experience under Section 1910.269(n)(3) confirms this conclusion. Several years ago, the Department of Justice, on OSHA's recommendation, indicted an electrical contractor for an alleged criminal violation of this section. At trial, however, neither DOJ [nor] OSHA could produce even a single expert witness to testify in support of the indictment as to what constitutes equipotential grounding, and the contractor was acquitted of this charge. There is no basis, therefore, now to extend the "equipotential zone" requirement to Part 1926, and it should be stricken from the final standards. Also, OSHA should issue compliance advice to its field personnel that Section 1910.269(n)(3) is unenforceable. [Ex. 0501]

With respect to the hearing testimony referenced by EEI, OSHA notes that the cited exchange involved Mr. Tomaseski, representing IBEW, questioning Mr. Brian Erga with ESCI (Tr. 1262–1263). Mr. Tomaseski did not testify during that exchange; he only asked questions.[411] Although OSHA does not dispute Mr. Erga's expertise in equipotential grounding, the Agency disagrees with his description of IEEE Std 1048 as "outdated." IEEE Std 1048–2003, *IEEE Guide for Protective Grounding of Power Lines,* was available at the time of the 2006 hearing (Ex. 0046). At that point, it had been available for only 3 years, and there is no evidence in the record that IEEE withdrew the consensus standard or otherwise disavowed it. There also is no evidence that IEEE Std 1048–2003 is inaccurate. On the basis of the rulemaking record considered as a whole, that consensus standard represents the best available guidance on what constitutes equipotential grounding. Paragraph (c) of final § 1926.962 requires employers to determine the proper grounding method based on the system involved. An engineering determination of the currents in the employee's body that will occur if the lines or equipment become reenergized during work generally is necessary for this purpose. IEEE Std 1048–2003 (previously IEEE Std 1048–1990) provides detailed guidelines on how to determine maximum body currents and how to calculate what those currents would be for a particular protective grounding system on a particular circuit (Ex. 0046). Consequently, OSHA concludes that there are guidelines available that can assist employers in developing grounding methods that will comply with final §§ 1910.269(n)(3) and 1926.962(c). However, as explained later, OSHA agrees that additional guidance from the Agency on this issue will facilitate compliance, and Appendix C to this final rule provides such guidance.

EEI did not provide a citation for the case on which it relies to support its assertion that existing § 1910.269(n)(3) is unenforceable. However, OSHA assumes that EEI is referring to *United States* v. *L.E. Myers Co.,* 2005 WL 3875213 (N.D.Ill. Nov. 2, 2005), *rev'd on other grounds,* 562 F.3d 845 (7th Cir. 2009), as that case was a criminal prosecution involving, among other issues, the equipotential grounding provision in existing § 1910.269. EEI's reliance on this case is misplaced. First, EEI incorrectly asserts that the Government elected not to call an expert witness on equipotential grounding in that case because the Government *could not* produce such an expert. In fact, before the trial in that case, the Government designated an expert witness who was prepared to describe the proper way to establish an equipotential zone consistent with the facts of the case. Second, the unfavorable decision in the case may mean simply that the jury decided that the defendant did not violate § 1910.269(n)(3), not that the standard is unenforceable.

The Agency concludes that the standard should explicitly state that the employer has a duty to determine (and be able to demonstrate) that the grounding practices in use provide an equipotential zone for the worker. IBEW commented that "[p]ersonal protective grounding is either entirely misunderstood or just not thought of as much as other issues involved [in electric power transmission and distribution] work" (Ex. 0230). OSHA infers from this statement that employers are not fully implementing the existing requirement for equipotential zones in § 1910.269(n)(3). Mr. Wilson Yancey with Quanta

[411] Although Mr. Tomaseski did not testify about proposed § 1926.962(c), IBEW generally supported the proposed provision in its posthearing comments (Ex. 0505).

that exceeds the current carrying capability of the circuit conductors (70 FR 34874). In other words, the maximum fault current on distribution secondaries of 600 volts or less can be high enough to melt the phase conductors carrying the fault current. If OSHA required protective grounding equipment to carry the maximum amount of fault current without regard to whether the phase conductors would fail, the size of the grounding equipment would be impractical. OSHA does not interpret existing § 1910.269(n)(4)(i) to require protective grounding equipment to be capable of carrying more current than necessary to allow the phase conductors to fail. (See OSHA Instruction CPL 02–01–038.) A protective grounding jumper sized slightly larger than a phase conductor would be sufficient to meet the existing standard.

To clarify this requirement, OSHA proposed, in paragraph (d)(1)(ii), to recognize certain conditions in which it would be permissible to use protective grounding equipment that would not be large enough to carry the maximum fault current indefinitely, but that would be large enough to carry this current until the phase conductor fails. First, the proposal would have required the grounding equipment to be capable of carrying the maximum fault current until the conductor protected by the grounding equipment failed. Second, the conductor would have been considered grounded only where the grounding equipment was protecting the employee after the conductor failed. In other words, the portion of the phase conductor between the grounding equipment and the employee protected by the grounding equipment would have had to remain intact under fault conditions. Third, since the phase conductor will likely fall once it fails, the proposal provided that "[n]o employees . . . be endangered by the failed conductor." OSHA requested comments on proposed paragraph (d)(1)(ii), including specifically whether the Agency should restrict the provision to lines and equipment operating at 600 volts or less.

Some commenters supported proposed paragraph (d)(1)(ii) (Exs. 0126, 0167, 0201, 0219, 0220). For example, Duke Energy supported this change, contending that "it relaxes overly restrictive rules" (Ex. 0201). Mr. Allan Oracion with Energy United EMC commented that proposed paragraph (d)(1)(ii) "is needed for fault current of lines at 600 volts or less because, if not, the ground wire would be too big to handle and use" (Ex. 0219).

However, most of the comments received on the proposed provision opposed it. (See, for example, Exs. 0125, 0127, 0149, 0159, 0172, 0179, 0227, 0230.) For instance, Ms. Wyla Wood with Mason County Public Utility District Number 3 commented:

> [T]he requirement to size a grounding jumper to be able to withstand the maximum fault current for the time necessary to have the grounded conductor fail to the point of separation and fall to the ground is impracticable in most situations due (1) to the required size of the grounding jumper and (2) the lack of adequate connection points at which to attach the grounding jumper. In a transmission system there usually is no neutral conductor so the grounding jumper must be attached to the tower or structure ground which at the most is only a 4/0 conductor or less. In the National Electric Safety Code and the National Electric[al] Code (NFPA 70), the connection to ground is only required to be sized to withstand the available fault current for the time required to have the electrical protective equipment operate. This would include relays seeing the fault current and opening breakers, tripping generating units off line, and/or allowing proper fusing to fail thereby creating an electrical opening in the system stopping the flow of current. The design requirements for electrical circuits as found in the NESC Section 9, 093.C1–9 and the NEC Chapter 2 Article 250 would need to be changed so that all new construction would have the ability to do what we believe you are asking in this section.
>
> Another consideration would be the physical size and weight of a temporary grounding jumper. As loads are becoming greater, the size of transmission and distribution conductors are becoming larger in size. If, for instance, the conductor was 756 MCM,[413] the grounding jumper would be required to be equal in size or capable of carrying the full fault current for the time necessary to have this conductor fail to the point of separation. A temporary grounding jumper of this size would be too heavy for a worker to lift and too stiff to form into the proper configuration required by some situations. OSHA should adhere to the requirements already in place in the above referenced regulations. [Ex. 0125]

EEI opposed the proposed requirement for similar reasons and argued that crews "would have to carry ten different sets of ground chains" (Ex. 0227).[414] IBEW also opposed the proposed provision, stating that the "requirement for properly sized grounds should not be [dependent] on [the] size [of the] conductor [to which] the ground is attached" (Ex. 0230). Noting that the size of grounds should not be a concern with transmission circuits, the union recommended that, if the grounds would be too large because of available fault current, employees should work the circuit as energized (*id.*).

It appears to the Agency that commenters that opposed proposed paragraph (d)(1)(ii) did not understand that this provision was intended as an exception to the requirement in proposed paragraph (d)(1)(i) that protective grounding equipment "be capable of conducting the maximum fault current that could flow at the point of grounding for the time necessary to clear the fault." However, based on the comments received, OSHA reconsidered the need for the proposed exception. Based on IBEW's comment, there appears to be no need for it on transmission circuits, and possibly even for any circuit of more than 600 volts (Ex. 0230). In addition, the hazards posed by faulted conductors that cannot carry fault current appear to be greater than those from working those conductors as energized because, when a faulted overhead conductor fails, it will drop. The ungrounded side may be energized (depending on where the failure occurred) and may contact the worker, who will not be protected against such contact as he or she would be if the work were performed energized. Therefore, OSHA is not adopting proposed paragraph (d)(1)(ii) in the final rule. However, note that, even though OSHA is not adopting proposed paragraph (d)(1)(ii), the final standard does not require protective grounding equipment to be capable of carrying more current than necessary to allow the phase conductors to fail.

Paragraph (d)(1)(ii) of the final rule, which OSHA proposed as paragraph (d)(1)(iii), requires protective grounding equipment to have an ampacity of at least No. 2 AWG copper. This provision is equivalent to language in existing § 1910.269(n)(4) and ensures that protective grounding equipment has a suitable minimum ampacity and mechanical strength. This proposed requirement received broad support. (See, for example, Exs. 0125, 0127, 0149, 0159, 0172, 0179.) Consequently, OSHA is adopting the requirement in the final rule without substantive change from the proposal.

Paragraph (d)(2) requires the impedance of the grounding equipment to be low enough so as not to delay the operation of protective devices in case of accidental energization. Existing § 1910.269(n)(4)(ii) requires protective grounding equipment to have "an

[413] MCM is million circular mils.

[414] OSHA believes that EEI intended to use the term "grounding equipment" rather than "grounding chains." Grounding chains are an outdated form of protective grounding equipment that are unlikely to meet current design standards for protective grounding equipment such as those in ASTM F855–09, *Standard Specifications for Temporary Protective Grounds to Be Used on De-energized Electric Power Lines and Equipment.*

Services testified: "We believe that the [equipotential grounding] standard should be entirely performance-based and put both the burden and responsibility on the employer, putting in place procedures and practices that protect employees from electrical hazards" (Tr. 1324–1325). The Agency agrees with Mr. Yancey. Therefore, OSHA is revising the proposed language to expressly require employers to demonstrate that temporary protective grounds have been placed at such locations and arranged in such a manner so as to prevent each employee from being exposed to hazardous differences in electric potential.

Two commenters objected to use of the phrase "equipotential zone" in the heading for proposed paragraph (c) and opposed a specific requirement for the creation of an "equipotential zone" (Exs. 0201, 0212). Duke Energy commented:

> The OSHA standard should not include specific requirements for the creation of an equipotential zone. There is not adequate information available to employers about how to effectively establish equipotential zones on distribution structures. Without this information, OSHA should not specify the technique of "equipotential" on those structures. In addition, OSHA should change the term "equipotential grounding" to "temporary protective grounding" which will allow employers to determine effective grounding techniques. [Ex. 0201]

Southern Company commented that the term "equipotential zone" is a misnomer because it "implies that the voltage difference between two points within the zone will be zero, therefore allowing no voltage to develop across the worker. This misconception eliminates consideration of the other critical parameters such as impedance of the temporary ground, fault levels, etc." (Ex. 0212). Like Duke Energy, Southern Company advocated use of the phrase "temporary protective grounding" in lieu of "equipotential zone" (*id.*).

In contrast, several commenters supported the requirement for an equipotential zone. (See, for example, Exs. 0155, 0162, 0186, 0230, 0505; Tr. 899–900, 1253–1254.) For example, Mr. Anthony Ahern of Ohio Rural Electric Cooperatives commented, "These grounding requirement[s] will be a major improvement. Equal-potential grounding/bonding should be required where ever it is possible to do so" (Ex. 0186). However, many of those who supported the proposed requirement recommended that OSHA provide more guidance on acceptable methods that employers can use to achieve the equipotential zone called for in the proposal. (See, for example, Exs. 0162, 0230, 0505; Tr. 899–900, 1253–1254.) For example, Mr. James Tomaseski with IBEW spoke to the need for guidance:

> [Protective grounding] is an essential procedure to ensure employee safety when performing work associated with transmission and distribution voltages. As important as it is, it is also a procedure that is commonly misunderstood and many times misapplied.
>
> In particular, many people, for some reason, do not understand the term "equipotential" and do not understand proper application of grounds to create an equipotential zone. This needs to be changed. Either in the rule itself or in existing Appendix C or a new appendix devoted to equipotential zones, OSHA should better describe what an equipotential zone actually is and how an equipotential zone is created and offer examples for overhead distribution, overhead transmission, and underground distribution of how to accomplish that task of creating an equipotential zone. [Tr. 899–900]

Mr. Steven Theis with MYR Group "strongly recommended that OSHA attempt to clarify acceptable grounding methods and/or configurations that would be considered adequate or acceptable" (Ex. 0162). Mr. Erga recommended that the Agency address grounding for underground systems and provided information for that purpose (Exs. 0474, 0475; Tr. 1256–1257).

OSHA disagrees with the commenters who objected to the term "equipotential zone." As used in paragraph (c) of the final rule, the word "equipotential" means that conductive objects within the worker's reach do not differ in electric potential to the point that it could endanger employees.[412] This definition differs slightly from the dictionary definition of "equipotential" (that is, having the same electric potential at every point), but the difference is clear from the regulatory text in paragraph (c). OSHA uses the term "equipotential zone" only in the heading. The text of paragraph (c) states the requirement precisely without using the term. In other words, the standard does not require what Southern Company alleges, that is, a zone of precisely equal electric potential.

OSHA agrees, however, that some employers can use assistance determining what an equipotential zone is. Appendix C to final Subpart V contains information designed to help employers develop grounding practices that will provide the equipotential zone required by the final rule. OSHA culled this information from the record, primarily IEEE Std 1048–2003 (Ex. 0046) and from determinations that the Agency made in this rulemaking (see, for example, the summary and explanation for final § 1926.964(b)(4)) and other rulemakings on safe levels of current in the body, including the 1994 preamble to final § 1910.269 (59 FR 4406) and the preamble to the rule on ground-fault protection (41 FR 55696–55704, Dec. 21, 1976). In addition, the Agency decided to provide a safe harbor of the type requested by Mr. Theis, so a new note in the final rule provides that grounding practices meeting the guidelines in Appendix C will comply with § 1926.962(c). This note will enable employers to adopt safe grounding practices that provide an equipotential zone without having to conduct a separate engineering determination, which should be particularly useful to contractors who perform work on many different systems. Following the guidelines in Appendix C, employers will be able to adopt a uniform set of grounding practices that will be acceptable for a wide range of above-ground and underground transmission and distribution systems. Employers may set their own grounding practices without following the guidelines in Appendix C, but the Agency reminds employers that the final rule requires them to be able to demonstrate that any practices selected will prevent each employee from being exposed to hazardous differences in electric potential.

Paragraph (d) of the final rule contains requirements that protective grounding equipment must meet. For the grounding equipment to protect employees completely, it must not fail while the line or electric equipment is energized. Thus, paragraph (d)(1)(i) requires protective grounding to have an ampacity high enough so that the equipment is capable of conducting the maximum fault current that could flow at the point of grounding during the period necessary to clear the fault. In other words, the grounding equipment must be able to carry the fault current for the amount of time necessary to allow protective devices to interrupt the circuit. OSHA adopted this provision from the first sentence of existing § 1910.269(n)(4)(i). There was broad support in the record for this requirement (see, for example, Exs. 0125, 0127, 0149, 0159, 0172, 0179). Consequently, OSHA is including it in the final rule as proposed.

As noted in the preamble to the proposed rule, the design of electric power distribution lines operating at 600 volts or less can present a maximum fault current and fault interrupting time

[412] See the summary and explanation for final § 1926.964(b)(4)(i) for an explanation of what OSHA considers to be a hazardous difference in electric potential.

impedance low enough to cause immediate operation of protective devices in case of accidental energizing of the lines or equipment." As noted in OSHA Instruction CPL 02–01–038, this requirement ensures that the protective grounding equipment does not contribute to any delay in the operation of the devices protecting the circuit. For certain lines and equipment, the design of the system allows some ground faults to occur without the operation of the circuit protection devices, regardless of the impedance of the grounding equipment. According to the OSHA Instruction, if the impedance of the grounding equipment does not contribute to delay in the operation of the circuit protection devices and if the impedance of this equipment is low enough to provide a safe work zone for employees (as required by existing § 1910.269(n)(3)), the employer is in compliance with existing § 1910.269(n)(4)(ii).

The Agency proposed to include this interpretation in the regulatory text of §§ 1910.269(n)(4) and 1926.962(d) by requiring the impedance of the grounding equipment to be low enough so that it "do[es] not delay the operation of protective devices," rather than low enough "to cause immediate operation of protective devices" in case of accidental energizing of the lines or equipment. OSHA did not receive any objection to the change in language and is adopting it without change in the final rule.

Paragraphs (d)(1) and (d)(2) help ensure the prompt clearing of the circuit supplying voltage to the point where the employee is working. Thus, the grounding equipment limits the duration and reduces the severity of any electric shock, though it does not prevent shock from occurring. (As discussed earlier, § 1926.962(c) of the final rule requires employers to protect employees from hazardous differences in electric potential.) OSHA included a note to paragraph (d) of the final rule referencing the ASTM and IEEE standards on protective grounding equipment (ASTM F855–09 and IEEE Std 1048–2003, respectively) so that employers can find additional information that may be helpful in their efforts to comply with the standard. Mr. Tom Chappell with Southern Company maintained that, because the ASTM standard does not require asymmetrical test current,[415] grounding equipment that satisfies that standard still might not be able to withstand the peak current and forces of a fully offset asymmetrical current (Ex. 0212.).

OSHA agrees that ASTM F855–09 does not require testing using asymmetrical current. However, that consensus standard provides for reduced maximum current-carrying ratings for temporary protective grounding equipment used with systems that present asymmetrical fault current (Ex. 0054).[416] In addition, there are other factors to consider in the selection and installation of appropriate protective grounding equipment, such as maximum forces imposed on protective grounding cables during a fault, circuit reclosing, inductive and capacitive coupling with adjacent energized lines, and clamp connection considerations (Ex. 0046). These factors are not adequately addressed in ASTM F855 because it is a specification standard for the design of protective grounding equipment, not a guide for selecting and using that equipment. However, IEEE Std 1048–2003 includes substantial useful information on these factors, including information on derating protective grounding equipment for systems with worst-case asymmetry (*id.*). The Agency added a reference to the IEEE standard in the note to address Mr. Chappell's concerns.

Mr. Chappell also asked whether "opening and locking a switch" removes the possibility that the circuit would contribute to the fault current and, thus, eliminates the need to account for that circuit in calculating fault current (Ex. 0212). The procedures required by final § 1926.961 ensure that circuits are deenergized and that they remain deenergized while employees are working on those circuits. However, OSHA determined that these procedures do not eliminate the risk that these circuits can become reenergized; in other words, grounding is still necessary (Exs. 0002, 0004).[417] The Agency does not believe that installing a lock will substantially reduce the risk of reenergization further. Tags required by final § 1926.961(c)(2) already would protect those switches, and a failure in the tagging procedures would be nearly as likely to render a lock ineffective for a person authorized to close the circuit.[418] Therefore, lines and equipment deenergized under the procedures required by final § 1910.269(m) or final § 1926.961 can still become reenergized through a failure in those procedures, and protective grounding equipment must be capable of withstanding the maximum current if the circuits become reenergized. However, the employer generally may assume that multiple (deenergized) sources of energy will not reenergize a deenergized line simultaneously. This assumption would limit the maximum current to the current from the highest capacity source. Nevertheless, the employer must assume that additional sources can contribute to the current through the protective grounding equipment for any sources that automatic switches could reenergize simultaneously.

Existing § 1926.954(h), (i), and (j) contain requirements relating to the impedance and ampacity of personal protective grounds. Paragraph (i) requires tower clamps to have adequate ampacity, and paragraph (j) establishes the same requirement for ground leads, with an additional restriction that they be no smaller than No. 2 AWG copper. Paragraph (h) requires the impedance of a grounding electrode (if used) to be low enough to remove the danger of harm to employees or to permit prompt operation of protective devices.

OSHA believes that the entire grounding system should be capable of carrying the maximum fault current and should have an impedance low enough to protect employees. The existing standard does not specify the impedance of grounding conductors or clamps, nor does it specify the ampacity of grounding clamps other than tower clamps. By addressing specific portions of the grounding systems but not addressing others, the existing standard does not provide complete protection for employees. Because the final rule's grounding requirements apply to the entire grounding system, OSHA believes that the revised standard will provide better protection for employees than the existing rule.

Paragraph (e), which is being adopted without substantive change from the proposal, requires employers to ensure that employees test lines and equipment

[415] In an alternating current system, current varies over time in a symmetrical pattern—the current forms a sine wave as a function of time, in which current above the zero axis is equal in magnitude and duration to current below the zero axis. In a fault condition, a direct current offset is added to the normal symmetrical current (still in the form of a sine wave), which results in current that is not symmetrical about the zero axis. The instantaneous current is higher due to this asymmetry than it would be when the current is symmetrical. The higher current also leads to higher mechanical forces on the protective grounding equipment. The degree of asymmetry depends on the ratio of the reactance of the circuit to its resistance, which is called the X/R ratio.

[416] ASTM F855–09 contains the same reduction in ratings as the 2004 edition that is in the rulemaking record as Ex. 0054.

[417] See, for example, the eight accidents described at *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=566034&id=170000459&id=14198543&id=783118&id=170228035&id=14342513&id=14445399&id=768002.*

[418] For example, the system operator could remove a tag or a lock from the wrong switch when energizing or deenergizing a circuit.

and verify that nominal voltage is absent before employees install any ground on those lines or equipment. If a previously installed ground is present, employees need not conduct a test. This provision prevents the grounding of energized equipment, which could injure the employee installing the ground. OSHA adopted this paragraph, which is equivalent to existing § 1926.954(d), from existing § 1910.269(n)(5).

Paragraphs (f)(1) and (f)(2) of the final rule set procedures for installing and removing grounds. To protect employees in the event that the "deenergized" equipment employees will ground is, or becomes, energized, these paragraphs require employees to attach the "equipment end" of grounding devices last and remove them first. These paragraphs also generally require employees to use a live-line tool for both procedures.

These provisions are similar to existing § 1926.954(e)(1) and (e)(2), except that the existing standard recognizes the use of a "suitable device" in addition to a live-line tool. As noted in the preamble to the proposal, OSHA expressed concern that this language implied that employees could use rubber insulating gloves to install and remove grounds under any circumstance (70 FR 34875). The Agency also noted that it is unsafe for an employee to be too close when connecting or disconnecting a ground (*id.*). Under the final rule, OSHA will consider any device insulated for the voltage, and that allows an employee to apply or remove the ground from a safe position, to be a live-line tool for the purposes of paragraphs (f)(1) and (f)(2).

OSHA based the corresponding paragraphs in the proposed rule on existing § 1910.269(n)(6) and (n)(7). Subsequent to the publication of existing § 1910.269 in 1994, some electric utilities complained that lines and equipment operating at 600 volts or less cannot always accommodate the placement and removal of a protective ground by a line-line tool. OSHA, therefore, proposed alternatives to enable employees to place protective grounds on this equipment in a manner that would still provide adequate protection. The proposal would have permitted the use of insulated equipment other than live-line tools for attaching protective grounds to, and removing them from, lines and equipment operating at 600 volts or less: (1) If the employer ensured that the line or equipment was not energized at the time or (2) if the employer could demonstrate that the employee would be protected from any hazard that could develop if the line or equipment was energized. For example, an employee could connect test equipment to a line to be grounded, and than an employee wearing rubber insulating gloves could apply the protective ground while the test equipment indicated that the line was deenergized. After the ground was in place, an employee could remove the test equipment.

Two commenters supported the proposal's approach to grounding lines and equipment operating at 600 volts or less (Exs. 0201, 0227). One additional commenter, who apparently supported the proposal, recommended that OSHA recognize the use of devices other than live-line tools for removing grounds at voltages less than 600 volts (Ex. 0212). This commenter cited the difficulty in "situations such as a pad mount transformer, [in which] the use of a live line tool is impractical due [to] space constraints and equipment design" (*id.*). There was no opposition to this part of proposed paragraphs (f)(1) and (f)(2), so OSHA is adopting the proposed exception for lines or equipment operated at 600 volts or less in this final rule.

Some rulemaking participants recommended that OSHA revise the language in proposed paragraph (f)(2) to provide additional protection for employees who are removing grounds from deenergized lines (Exs. 0162, 0230; Tr. 900–901). Mr. James Tomaseski with IBEW described the problem and recommended a solution as follows:

> The removal of protective grounds has caused many fatal accidents over the years. As far back as the IBEW has maintained accident records, removal of grounds in the wrong sequence has been the principal factor in these grounding accidents.
>
> One might assume that the same hazard exists during installation of the grounds, but the situation is actually different. The accident always occurs when an employee is in the process of removing a ground potential clamp from one of the number of grounds that are connected in the same location on the pole or structure.
>
> Mistake is made when a ground end is removed and the other end is connected to the phase conductor, and usually because of induced voltage from a parallel or crossing energized circuit, the employee ends up holding an energized ground clamp in his or her hand while wearing only leather gloves.
>
> This can be rectified by prescribing a work rule that, when more than one ground end connection is assembled in the same general area on the pole or the structure, all phase conductor ends must be removed first before any ground ends are removed. This is consistent with the new code language that Subcommittee 8 of the National Electric Safety Code has adopted to address this problem. [Tr. 900–901]

OSHA agrees that the process of removing grounds can be even more dangerous than installing them. As noted earlier, if a worker removes the grounded end of a grounding cable before the line end, the worker, who typically will not be using a live-line tool or other form of protective equipment, will be in contact with any residual voltage on the "deenergized" line or equipment, which may be from induced voltage or voltage backfeed. As Mr. Tomaseski notes, this situation has resulted in fatal accidents (Ex. 0004[419]). However, the final rule prohibits the practice of removing the ground end after the line or equipment end, including when the grounding cables are crossed or parallel. Although the rule does not prescribe a particular method of installing and removing parallel or crossed conductors, OSHA expects an employer's work rules and training to adequately ensure the correct order of removal of grounds however employees install them. Depending on the circumstances, the employer may have to instruct employees to remove all phase conductor ends first so as to avoid confusion between multiple grounds. For the reasons explained by IBEW, the Agency does not consider a work rule that simply repeats the OSHA standard to be adequate to prevent employees from removing the grounded end of the wrong cable in circumstances in which it is reasonably likely that employees will mistake one ground for another during the removal process. If the employer's work methods could cause confusion for employees regarding the identity of a cable or cable end, then the employer must design the work rules and training to prevent employees from removing the ground ends of cables still attached at their line or equipment ends.

In addition, note that, during the periods before employees install all of the grounds and after employees remove the first end of a ground, the line or equipment involved must be considered as energized (under final § 1926.960(b)(2)). As a result, the live work provisions in final § 1926.960(c) apply during these periods. The employer's work rules and training must also account for this requirement. For example, when an employee cuts a deenergized and grounded conductor, unless both sides of the cut are grounded or connected by a bonding jumper, the employee must treat as energized the end that is not connected to ground when he or she is making the cut. In this case, the employer's work rules must either provide for grounding

[419] See, for example, the two accidents described at *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=200780245&id=922914.*

both sides of the cut or ensure that the employee complies with the minimum approach-distance requirements with respect to the ungrounded end of the conductor.

As the preamble to the proposal noted, with certain underground cable installations, the current from a fault at one location along the cable can create a substantial potential difference between the earth at that location and the earth at other locations (70 FR 34875). Under normal conditions, this is not a hazard. However, if an employee is in contact with a remote ground (by being in contact with a conductor grounded at a remote station), he or she can be exposed to the difference in potential (because he or she also is in contact with the local ground). To protect employees in such situations, final paragraph (g) prohibits grounding cables at remote locations if a hazardous potential transfer could occur under fault conditions. OSHA adopted this provision from existing § 1910.269(n)(8), which has no counterpart in existing Subpart V. Mr. James Junga with Local 223 of the Utility Workers Union of America expressed support for this provision (Ex. 0197). OSHA is adopting paragraph (g) without substantive change from the proposal.

Paragraph (h) addresses the removal of grounds for test purposes. Employers may permit employees to remove grounds for test purposes following the procedure specified by paragraph (h). Existing Subpart V contains a comparable requirement in § 1926.954(g). However, the existing standard simply requires employees to take extreme caution when removing grounds for testing. In the preamble to the proposed rule, OSHA indicated that it did not believe that the existing language contains sufficient safeguards for employees (70 FR 34875). Therefore, the Agency is adopting performance criteria for testing procedures. OSHA took the language in final paragraph (h) from existing § 1910.269(n)(9). During the test procedure, the employer must: (1) Ensure that each employee uses insulating equipment, (2) isolate each employee from any hazards involved, and (3) implement any additional measures necessary to protect each exposed employee in case the previously grounded lines and equipment become energized. OSHA believes that the final rule protects employees better than the existing rule. The Agency received no comments on this provision in the proposal and is adopting it without substantive change from the proposal.

14. Section 1926.963, Testing and Test Facilities

Section 1926.963 of the final rule contains safety work practices covering electrical hazards arising from the special testing of lines and equipment (namely, in-service and out-of-service, as well as new, lines and equipment) to determine maintenance needs and fitness for service. Generally, the NESC specifies the need to conduct tests on new and idle lines and equipment as part of normal checkout procedures, in addition to maintenance evaluations. As stated in paragraph (a), final § 1926.963 applies only to testing involving interim measurements using high voltage, high power, or combinations of both high voltage and high power, as opposed to testing involving continuous measurements as in routine metering, relaying, and normal line work.

OSHA adopted this section from existing § 1910.269(o). Existing Subpart V has no counterpart to the requirements in this section. In the preamble to the proposal, the Agency stated its belief that employees perform these high-voltage and high-current tests during construction work and that employees and employers would benefit from the inclusion of these provisions in the construction standard instead of a reference to § 1910.269 (70 FR 34876). However, in the proposal, OSHA requested comments on the need to include proposed § 1926.963 in Subpart V.

The Agency received little response to this request for comments, but commenters who did respond supported the inclusion of proposed § 1926.963 in the final rule. (See, for example, Exs. 0126, 0175, 0186, 0213.) TVA expressed its support as follows:

> Our experience shows that the tests performed before new equipment and conductors are energized for electrical service on the system may be performed by either the construction contractor or the owner's maintenance and operations employees. It is recommended that the requirements in 1910.269(o) be repeated in proposed Sec. 1926.963. [Ex. 0213]

With the endorsement of these commenters, OSHA included § 1926.963 on testing and test facilities in the final rule.

For the purposes of this section, OSHA assumes that high-voltage testing involves voltage sources having sufficient energy to cause injury and having magnitudes generally in excess of 1,000 volts, nominal. High-power testing involves sources of fault current, load current, magnetizing current, or line dropping current for testing, either at the rated voltage of the equipment under test or at lower voltages. Final § 1926.963 covers such testing in laboratories, in shops and substations, and in the field. However, the Agency believes that testing in laboratories and shops will almost always fall under final § 1910.269(o), rather than final § 1926.963.

Examples of typical special tests in which employees use either high-voltage sources or high-power sources as part of operation, maintenance, and construction of electric power transmission and distribution systems include cable-fault locating, large capacitive load tests, high current fault-closure tests, insulation-resistance and leakage tests, direct-current proof tests, and other tests requiring direct connection to power lines.

Excluded from the scope of final § 1926.963 are routine inspection- and maintenance-type measurements made by qualified employees for which the hazards associated with the use of intrinsic high-voltage or high-power sources require only the normal precautions specified by Subpart V. The work practices for these routine tests would have to comply with the rest of final Subpart V. Because this type of testing poses hazards that are identical to other types of routine electric power transmission and distribution work, OSHA believes that the requirements of final Subpart V, other than § 1926.963, adequately protect employees performing these tests. Two typical examples of such excluded test work procedures would be "phasing-out" testing and testing for a "no voltage" condition. To clarify the scope of this section, OSHA included a note to this effect after paragraph (a).

Paragraph (b)(1), which is being adopted without substantive change from the proposal, requires employers to establish and enforce work practices governing employees engaged in certain testing activities. These work practices delineate precautions that employees must observe for protection from the hazards of high-voltage or high-power testing. For example, if an employer uses high-voltage sources in the testing, the employer must institute safety practices under paragraph (b)(1) to protect employees against such typical hazards as inadvertent arcing or voltage overstress destruction, as well as accidental contact with objects that have induced voltage from electric field exposure. If an employer uses high-power sources in the testing, the employer must establish safety practices to protect employees against such typical hazards as ground voltage rise, as well as exposure to excessive

electromagnetic forces associated with the passage of heavy current.

These practices apply to work performed at both permanent and temporary test areas (that is, areas permanently located in laboratories or shops or in temporary areas located in the field). At a minimum, the safety work practices include:

(1) Safeguards for the test area to prevent inadvertent contact with energized parts,

(2) Safe grounding practices,

(3) Precautions for the use of control and measuring circuits, and

(4) Periodic checks of field test areas.

Final paragraph (b)(2) complements the general rule on the use of safe work practices in test areas with a requirement that employers ensure that each employee involved in these safety test practices receives training in safe work practices upon his or her initial assignment to the test area. This paragraph simply makes explicit one type of training required in any event by the general training provisions in final § 1926.950(b). Paragraph (b)(2) of final § 1926.963 also requires the employer to provide retraining as required by final § 1926.950(b). OSHA is adopting paragraph (b)(2) of final § 1926.963 without substantive change from the proposal.

Although specific work practices used in test areas generally are unique to a particular test, three basic elements affecting safety are commonly present to some degree at all test sites: Safeguarding, grounding, and the safe use of control and measuring circuits. By considering safe work practices in these three categories, OSHA provided a performance-oriented standard applicable to high-voltage and high-power testing and test facilities.

OSHA believes that employers can best achieve safeguarding when they provide it both around and within test areas. By controlling access to all parts that are likely to become energized by either direct or inductive coupling, the standard will prevent accidental contact by employees. Within test areas, whether temporary or permanent, employers can achieve a degree of safety by ensuring that employees observe safeguarding practices that control access to test areas. Therefore, paragraph (c)(1), which is being adopted without substantive change from the proposal, requires that employers provide such safeguarding if the test equipment or apparatus under test could become energized as part of the testing by either direct or inductive coupling. A combination of guards [420] and barriers [421] or barricades [422] can provide protection to all employees in the vicinity of the testing. In final paragraph (c)(1) and elsewhere in paragraphs (b) and (c) of final § 1926.963, OSHA changed the words "guarding" and "guarded" to "safeguarding" and "safeguarded," respectively, to clarify when employers may use protective measures other than guards, such as barricades.

Paragraph (c)(2), which is being adopted without substantive change from the proposal, requires employers to guard permanent test areas, such as laboratories, by having them completely enclosed by walls or some other type of physical barrier. In the case of field testing, paragraph (c)(3) provides a level of safety for temporary test sites comparable to that achieved in permanent test areas. For these areas, if employers do not provide permanent fences or gates, employers must either (1) use distinctively colored safety tape—approximately waist high—with safety signs attached or (2) station one or more observers to monitor the test area. Paragraph (c)(3), which is being adopted without substantive change from the proposal, also accepts safeguarding of test areas by any barriers or barricades that limit access to the test area in a manner that is physically and visually equivalent to the safety tape with signs that employers can use under paragraph (c)(3)(i).

Since failing to remove a temporary safeguarding means when it is not required can severely compromise its effectiveness, employers must make frequent safety checks of the safeguarding means to monitor its use. For example, leaving barriers in place for a week when the employer performs testing only an hour or two per day is likely to result in disregard for the barriers. Accordingly, final paragraph (c)(4) requires employers to ensure the removal of temporary safeguards when they are no longer needed for the protection of employees.[423] OSHA changed the word "barrier" in this paragraph to "safeguards" because "safeguards" more accurately describes the protective measures required by paragraph (c)(3) than barriers.

Suitable grounding is another important work practice that employers can use to protect employees from the hazards of high-voltage or high-power testing. If employers use high currents in the testing, they can use an isolated ground-return conductor, adequate for the service, so that heavy current, with its attendant voltage rise, will not pass in the ground grid or the earth. Another safety consideration involving grounding is that employers should maintain at ground potential all conductive parts accessible to the test operator while the equipment is operating at high voltage. Final paragraph (d) contains requirements for proper grounding at test sites.

Final paragraph (d)(1) requires that employers establish and implement safe grounding practices for test facilities that will ensure proper grounding of conductive parts accessible to the test operator and that will ensure that all ungrounded terminals of test equipment or apparatus under test are treated as energized until determined to be deenergized by tests. The final rule drops the exception for "portions of the equipment that are isolated from the test operator by guarding" specified in proposed paragraph (d)(1) because guarded parts of equipment are not accessible to the operator.

Paragraph (d)(2), which is being adopted without substantive change from the proposal, requires employers to ensure either that visible grounds are applied automatically, or that employees using properly insulated tools manually apply visible grounds, to the high-voltage circuits. The grounds must be applied after the circuits are deenergized but before employees perform work on the circuit or on the item or apparatus under test. This paragraph also requires common ground connections to be solidly connected to the test equipment and apparatus under test.

Paragraph (d)(3), which is being adopted without substantive change from the proposal, addresses hazards resulting from the use of inadequate ground returns. Inadequate ground returns can result in a voltage rise in the ground grid or in the earth whenever high currents occur during the testing.[424] This paragraph requires the use of an isolated ground return so that no intentional passage of current, with

[420] A guard is a physical barrier to an area or hazard. It is usually an enclosure.

[421] According to final § 1926.968, a "barrier" is "[a] physical obstruction that prevents contact with energized lines or equipment or prevents unauthorized access to a work area." Fences and walls are examples of barriers.

[422] According to final § 1926.968, "barricade" is "[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."

[423] Employees who serve as test observers under final paragraph (c)(3)(iii) need not leave the area. However, they no longer function as test observers when the protection they provide is no longer needed.

[424] High current can occur during high-voltage testing, in which case the testing would also be high-power testing.

its attendant voltage rise, can occur in the ground grid or in the earth. However, under some conditions, it may be impractical to provide an isolated ground return. In such cases, it would not be reasonable to require an isolated ground-return conductor system. Therefore, final paragraph (d)(3) provides an exception to the requirement for an isolated ground return if the employer cannot use isolated ground returns because of the distance between the test site and the electric energy source *and* if the employer protects employees from hazardous step and touch potentials that may develop.[425] Employers must always consider the possibility of voltage gradients developing in the earth during impulse, short-circuit, inrush, or oscillatory conditions. Examples of acceptable protection from step and touch potentials include suitable electrical protective equipment and the removal of employees from areas that may expose them to hazardous potentials.

A note following final paragraph (d)(3)(ii) indicates that Appendix C contains information on measures employers can take to protect employees from hazardous step and touch potentials. Mr. Brad Davis with BGE noted that IEEE Std 80, *Guide for Safety in AC Substation Grounding,* is a good reference for guidance on protecting against hazardous step and touch potentials (Ex. 0126). OSHA reviewed IEEE Std 80–2000 and agrees that it does provide useful guidance on measures to protect employees from hazardous differences in electric potential, even though it applies to substation grounding rather than to high-voltage and high-power testing. Therefore, OSHA included references to this standard in both Appendix C, Protection from Step and Touch Potentials, and Appendix G, Reference Documents.

Final paragraph (d)(4) addresses situations in which grounding through the power cord of test equipment would prevent employers from taking satisfactory measurements or would result in greater hazards for test operators. Normally, an equipment grounding conductor in the power cord of test equipment connects it to a grounding connection in the power receptacle. However, in some circumstances, this practice can prevent satisfactory measurements, or current induced in the grounding conductor can cause a hazard to employees. If these conditions exist, the use of the equipment grounding conductor within the cord would not be mandatory. In such situations, final paragraph (d)(4) requires the employer to use a ground clearly indicated in the test set up (for example, a ground with a distinctive appearance), and the employer must demonstrate that the ground used affords safety equivalent to the protection afforded by an equipment grounding conductor in the power supply cord. OSHA reworded this paragraph in the final rule for clarity.

Final paragraph (d)(5) addresses grounding after tests and requires the employer to ensure that a ground is placed on the high-voltage terminal and any other exposed terminals when any employee enters the test area after equipment is deenergized. In the case of high capacitance equipment or apparatus, before any employee applies the direct ground, the employer must discharge the equipment or apparatus through a resistor having an adequate rating for the available energy. A direct ground must be applied to exposed terminals after the stored energy drops to a level at which it is safe to do so. OSHA adopted this paragraph substantially as proposed. The Agency reworded paragraph (d)(5)(i) to explicitly require the employer to discharge equipment or apparatus before a direct ground is applied. The proposed rule implied this requirement by ordering paragraph (d)(5)(i), which required employers to discharge the equipment or apparatus, before paragraph (d)(5)(ii), which required the application of a direct ground.

Paragraph (d)(6), which is being adopted without substantive change from the proposal, addresses the hazards associated with field testing in which employers use test trailers or test vehicles. This paragraph requires that the chassis of such vehicles be grounded and further requires employers to protect employees, by bonding, insulation, or isolation, against hazardous touch potentials with respect to the vehicle, instrument panels, and other conductive parts accessible to the employees. The following examples describe the protection provided by each of these methods:

(1) Protection by bonding: Provide, around the vehicle, an area covered by a metallic mat or mesh of substantial cross-section and low impedance, with the mat or mesh bonded to the vehicle at several points and to an adequate number of driven ground rods or, where available, to an adequate number of accessible points on the station ground grid. All bonding conductors must be of sufficient electrical size to keep the voltage developed during maximum anticipated current tests at a safe value. The mat must be of a size that precludes simultaneous contact with the vehicle and with the earth or with metallic structures not adequately bonded to the mat.

(2) Protection by insulation: Provide, around the vehicle, an area of dry wooden planks covered with rubber insulating blankets. The physical extent of the insulated area must be sufficient to prevent simultaneous contact between the vehicle, or the ground lead of the vehicle, and the earth or metallic structures in the vicinity.

(3) Protection by isolation: Provide an effective means to exclude employees from any area where they could make simultaneous contact between the vehicle (or conductive parts electrically connected to the vehicle) and other conductive materials. Employers may use a combination of barriers, together with effective, interlocked gates, to ensure that the system is deenergized when an employee enters the test area.

Finally, a third category of safe work practices applicable to employers performing testing work, which complements the first two safety work practices of safeguarding and grounding, involves work practices associated with the installation of control and measurement circuits used at test facilities. Employers must adopt the practices necessary for the protection of personnel and equipment from the hazards of high-voltage or high-power testing for every test using special signal-gathering equipment (that is, meters, oscilloscopes, and other special instruments). In addition, special settings on protective relays and reexamination of backup schemes may be necessary to ensure an adequate level of safety during the tests or to minimize the effects of the testing on other parts of the system under test. Accordingly, final paragraphs (e)(1) through (e)(4) address the principal safe work practices associated with control and measuring circuits used in the test area.

Generally, control wiring, meter connections, test leads, and cables should remain within the test area. Paragraph (e)(1), which is being adopted without substantive change from the proposal, contains requirements to minimize hazards involving test wiring routed outside the test area. 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

[425] The term "step and touch potentials" refers to voltages that can appear between the feet of an observer or between his or her body and a grounded object.

with equivalent safety, such as guarding the area so that employees do not have access to parts that could be hazardous.

Paragraph (e)(2), which is being adopted without substantive change from the proposal, prevents possible hazards that arise from inadvertent contact with energized accessible terminals or parts of meters and other test instruments. Employers must isolate meters and instruments with such terminals or parts from employees performing tests. If an employer provides isolation by locating test equipment in metal compartments with viewing windows, the employer must also provide interlocks that interrupt the power supply when someone opens the compartment cover.

Paragraph (e)(3) of the final rule addresses protecting temporary wiring and its connections from damage. This paragraph requires the employer to protect temporary wiring and its connections against damage, accidental interruptions, and other hazards. This paragraph also requires employers to keep the functional wiring used for the test set-up (that is, signal, control, ground, and power cables) separate from each other to the maximum extent possible, thereby minimizing the coupling of hazardous voltages into the control and measuring circuits. Paragraph (e)(3) in the proposal would have required employers to *secure* "[t]he routing and connections of temporary wiring" against hazards. Paragraph (e)(3) of the final rule clarifies that the employer has to *protect* the temporary wiring and its connections against hazards.

Paragraph (e)(4) of the final rule identifies a final safety work practice requirement related to control circuits. This paragraph, which is being adopted without substantive change from the proposal, requires the presence of a test observer in the test area during the entire test period if employees will be in the area. The test observer must be capable of immediately deenergizing all test circuits for safety purposes.

Since the conditions for conducting field tests differ in important respects from those for laboratory tests, employers must take extra care to ensure appropriate levels of safety. Under field test conditions, employers usually do not provide permanent fences and gates for isolating the field test area, nor is there a permanent conduit for the instrumentation and control wiring. Additional hazards include sources of high-voltage electric energy in the vicinity, other than the source of test voltage.

It is not always possible in the field for the employer to erect fences and interlocked gates to prevent employee ingress into a test area, as is possible during laboratory testing. Consequently, as described earlier under the summary and explanation for final paragraph (c)(3), employers must use readily recognizable means to discourage such ingress during field testing. Accordingly, final paragraph (f)(1) requires employers to adopt safety practices that provide for a safety check of temporary and field test areas before employees begin each group of continuous tests (that is, a series of tests conducted one immediately after another). Final paragraph (f)(2) provides that the test operator responsible for the testing verify, before the initiation of a continuous period of testing, the status of several safety conditions. These conditions include the state and placement of barriers and safeguards, the condition of status signals, the marking and availability of disconnects, the provision of clearly identifiable ground connections, the provision and use of necessary personal protective equipment, and the separation of signal, ground, and power cables. OSHA adopted paragraphs (f)(1) and (f)(2) without substantive change from the proposal.

Section 1926.964, Overhead Lines and Live-Line Barehand Work

As noted in paragraph (a)(1), § 1926.964 of the final rule applies to work performed on or near overhead lines and equipment. The types of work performed on overhead lines and addressed by this section include the installation and removal of overhead lines, live-line barehand work, and work on towers and structures, which typically expose employees to the hazards of falls and electric shock.

Section 1926.955 of existing Subpart V covers overhead lines. As OSHA noted in the preamble to the proposal, several requirements in the existing standard are redundant, and the Agency believes the existing section needs better organization (70 FR 34878). For example, existing paragraphs (c) and (d) both apply to the installation of lines parallel to existing lines. Existing paragraph (c)(3) requires the employer to ground lines being installed where there is a danger of hazardous induced voltage, unless the employer makes provisions to isolate or insulate employees. Paragraph (d)(1) of existing § 1926.955 contains a similar requirement, and the rest of paragraph (d) specifies exactly how employers are to install the grounding.

Paragraph (q) of existing § 1910.269 also addresses work on overhead lines. When OSHA proposed to revise Subpart V, the Agency stated that it believed that "the newer standard is much better organized, contains no redundancies, and better protects employees than the older construction standard" (70 FR 34878). Therefore, the Agency used existing § 1910.269(q), rather than existing § 1926.955, as the base document in developing proposed § 1926.964. However, OSHA also proposed requirements for § 1926.964 that the Agency took from existing § 1926.955 pertaining specifically to construction work. (Paragraph (q) of existing § 1910.269 does not contain these requirements, because it does not apply to construction.) For example, OSHA included the requirements of existing § 1926.955(b), which applies to metal-tower construction, in the proposed revision of Subpart V.

Paragraph (a)(2), which is being adopted without substantive change from the proposal, requires the employer to determine that elevated structures such as poles and towers are strong enough to withstand the stresses imposed by the work employees will perform on them. For example, if the work involves removing and reinstalling an existing line on a utility pole, the pole must withstand the weight of the employee (a vertical force) and the forces resulting from the release and replacement of the overhead line (a vertical and possibly a horizontal force). The additional stress involved may cause the pole to break, particularly if the pole is rotted at its base. If the pole or structure cannot withstand the imposed loads, the employer must reinforce the pole or structure so that failure does not occur. This rule protects employees from hazards posed by the failure of a pole or other elevated structure. OSHA took this requirement, which is equivalent to existing § 1926.955(a)(2), (a)(3), and (a)(4), from existing § 1910.269(q)(1)(i).

In ascertaining whether a wood pole is safe to climb, as required under paragraph (a)(2), it is important to check the actual condition of the pole for the presence of decay or other conditions adversely affecting the strength of the pole.[426] Appendix D to Subpart V contains methods of inspecting and testing the condition of wood structures before employees climb those structures. OSHA took these methods,

[426] In some cases, the host employer will know about the condition of a pole, such as when the host employer has results from a pole-inspection program. Host employers must pass any such information to employees (as required by final § 1926.952(a)(1)) and contractors (as required by final § 1926.950(c)(1)(ii)). However, in most cases, the employee at the worksite will still need to inspect the structure for deterioration to determine whether it is safe to climb.

which employers can use in ascertaining whether a wood structure is capable of sustaining the forces imposed by an employee climbing it, from Appendix D to existing § 1910.269. Note that the employer also must ascertain whether the pole is capable of sustaining any additional forces imposed on it during the work, such as the weight of employees working on it, the weight of any new or replaced equipment installed on it, and forces resulting from putting tension on conductors and guys. A note to this effect follows paragraph (a)(2). The note also references Appendix D.

The employer can comply with final paragraph (a)(2) by ensuring that the design of support structures can withstand the stresses involved, training employees in proper inspection and evaluation techniques, and enforcing company rules that adhere to the standard. OSHA notes that employees in the field do not necessarily have structural engineering skills, so in many situations—such as those involving the installation of new, heavier, equipment in place of older, lighter, equipment—the employer might need to have its engineering staff conduct engineering analyses to ensure that the pole can withstand the stresses involved. (Typically, utilities perform this task in the initial design of the system or when they plan changes to it.) In such situations, the Agency still expects the employer to have the determination of the condition of the pole or structure made at the worksite by an employee who is capable of making this determination.

When employees handle a pole near overhead lines, it is necessary to prevent the pole from contacting exposed, energized lines. Paragraph (a)(3)(i) of final § 1926.964 prohibits letting the pole come into direct contact with exposed, energized overhead conductors. One measure commonly used to prevent such contact involves pulling conductors away from the area where the pole will go. OSHA took final paragraph (a)(3)(i), which is equivalent to existing § 1926.955(a)(5)(i), from existing § 1910.269(q)(1)(ii).

Mr. Brian Erga with ESCI recommended that OSHA revise this section to specify the measures that employers must take if employees bring poles within the minimum approach distance, explaining:

> Poles whether wood, steel or concrete are conductive, often very conductive, and should never enter MAD without insulated cover-up. However, the task of taking poles into MAD is conducted thousands of times each day across the US. OSHA needs to insure that safe work practices are used when working with poles. [Ex. 0155]

Paragraph (a)(3)(i) of the final rule protects employees against injury from contact with conductors knocked down by poles being set, moved, or removed. OSHA did not design this paragraph primarily to protect against electric shock caused by approaching too closely to energized parts. OSHA agrees with Mr. Erga that poles are conductive and that employees must not take them within the minimum approach distance of energized parts. However, final § 1926.960(c)(1)(iii) already prohibits employees from taking any conductive object closer to exposed energized parts than the employer's established minimum approach distance, unless employers take certain protective measures. The Agency believes that it is unnecessary to repeat those requirements or alter them here. However, it is possible that the preamble to the proposal prompted Mr. Erga's comment; the preamble indicated that "[m]easures commonly used to prevent . . . contact [between poles and lines] include installation of insulating guards on the pole" (70 FR 34879). In light of Mr. Erga's apparent confusion, OSHA did not include this example in the final explanation for paragraph (a)(3)(i). In any event, Mr. Erga's recommendation does not protect employees from injury by conductors knocked down by poles. Therefore, OSHA is adopting paragraph (a)(3)(i) substantively as proposed.

Paragraph (a)(3)(ii) requires the employer to ensure that employees who handle a pole while setting, moving, or removing it near an exposed energized overhead conductor use electrical protective equipment or insulated devices and do not contact the pole with uninsulated parts of their bodies. OSHA took this provision from existing § 1910.269(q)(1)(iii). NIOSH supported proposed paragraph (a)(3)(ii), noting that "[e]lectrocutions have occurred when ground workers not wearing PPE were guiding poles into holes and a powerline was contacted" (Ex. 0130). OSHA is adopting paragraph (a)(3)(ii) without change from the proposal.

Existing § 1926.955(a)(6)(i), which OSHA did not adopt in final § 1926.964, requires employers to ensure that employees standing on the ground do not contact equipment or machinery that is working adjacent to energized lines or equipment, unless the employees are using suitable electrical protective equipment. The final rule covers the hazards of using mechanical equipment near energized parts in § 1926.959, discussed earlier in this section of the preamble, and the Agency does not believe that there is a need for redundancy in § 1926.964. In fact, OSHA designed the final rule to eliminate the redundant and conflicting requirements contained in existing Subpart V. OSHA notes that it also left existing § 1926.955(a)(5)(ii), (a)(6)(ii), and (a)(8) out of final § 1926.964 because final § 1926.959 already adequately covers the hazards addressed by these provisions (that is, hazards related to operation of mechanical equipment near energized parts).

Paragraphs (a)(3)(i) and (a)(3)(ii) protect employees from hazards caused by falling power lines and by the pole's contacting the line. They apply in addition to other applicable provisions, including requirements in final § 1926.959(d) for operations involving mechanical equipment and in final § 1926.960(c)(1)(iii) for minimum approach distances.

To protect employees from falling into holes dug for poles, paragraph (a)(3)(iii), which is being adopted without substantive change from the proposal, requires employers to physically guard the holes, or ensure that employees attend the holes, whenever anyone is working nearby.[427] OSHA took this provision, which is equivalent to existing § 1926.955(a)(7), from existing § 1910.269(q)(1)(iv).

Paragraph (b) addresses the installation and removal of overhead lines. OSHA took the provisions contained in this paragraph from existing § 1910.269(q)(2), which OSHA based in large part on existing § 1926.955(c) (stringing and removing deenergized conductors) and § 1926.955(d) (stringing adjacent to energized lines). However, the final rule, as with existing § 1910.269(q)(2), combines these provisions into a single paragraph (b). OSHA believes that these provisions, which combine and simplify the construction requirements for stringing overhead lines, will be easier for employers and employees to understand. OSHA added "(overhead lines)" after "overhead conductors or cable" in the introductory text to paragraph (b) in the final rule to clarify that paragraph (b) uses these terms synonymously.

Paragraph (b)(1) requires employers to take precautions to minimize the possibility that conductors and cables, during installation and removal, will contact energized power lines or equipment. This paragraph requires

[427] For the purpose of § 1926.964(a)(3)(iii), "nearby" means that an employee on the ground is near enough to the hole that he or she could fall into it.

employers to do so by stringing conductors using the tension-stringing method (which keeps the conductors off the ground and clear of energized circuits) or by using barriers, such as rope nets and guards (which physically prevent one line from contacting another). Employers also may use equivalent measures. This paragraph protects employees against electric shock and against the effects of equipment damage resulting from accidental contact between the line and energized parts during line installation and removal.

Ms. Salud Layton with the Virginia, Maryland and Delaware Association of Electric Cooperatives asked the Agency to "clarify that this requirement is necessary to avoid hazards only when crossing or paralleling existing energized cables and conductors" (Ex. 0175).

OSHA generally agrees with this comment, but notes that the required precautions are necessary whenever the lines can contact any energized parts, not just existing energized cables and conductors. Therefore, to clarify the rule, the Agency added the clause "[w]hen lines that employees are installing or removing can contact energized parts" at the beginning of final paragraph (b)(1).

Even though the precautions taken under paragraph (b)(1) minimize the possibility of accidental contact, there is still a significant residual risk that the line could contact energized parts during installation or removal of the line. In the 1994 rulemaking on § 1910.269, OSHA concluded that the hazards posed during line installation or removal were equivalent to the hazards posed during the operations of mechanical equipment near energized parts (59 FR 4406). Employee exposure to hazardous differences in potential occurs if, during installation or removal of the line, the conductor or the equipment installing or removing the conductor contacts an energized part. The methods of protection employers can apply also are the same in both cases. Therefore, the Agency concluded that the approach applied to the hazard associated with contact between mechanical equipment and overhead lines also should apply to the hazard associated with contact between an existing energized conductor and a line during installation and removal of the line. Accordingly, paragraph (b)(2) of proposed § 1926.964 adopted the requirements of proposed § 1926.959(d)(3) by reference for conductors, cables, and pulling and tensioning equipment in situations in which employees install or remove conductors or cables close enough to energized conductors that certain failures (in the pulling or tensioning equipment, the conductor or cable being pulled, or the previously installed lines or equipment) could energize the pulling or tensioning equipment, conductor, or cable. Therefore, the proposal essentially provided that the employer would have to institute measures to protect employees from hazardous differences in potential at the work location. (See the discussion of final § 1926.959(d)(3) and Appendix C to Subpart V for acceptable methods of compliance.)

Mr. Brian Erga with ESCI recommended that the heading to paragraph (b)(2) be shortened from "Conductors, cables, and puling and tensioning equipment" to "Pulling and Tensioning Equipment" (Ex. 0155). Mr. Erga also proposed extensive new language for this provision, explaining:

> [ESCI's] proposed changes to 1926.694(b)(2) [use] current industry safe work practices accepted in the electrical industry and supported by IEEE 516 Section 7.5 and IEEE 1048 Section 10. These changes are the current thinking of the industry and should be followed to protect workers near mechanical equipment. [*Id.*]

As discussed earlier in this section of the preamble, Mr. Erga made a similar proposal with respect to proposed § 1926.959(d)(3) (*id.*). OSHA rejected that proposal. (See the summary and explanation for final § 1926.959(d)(3), earlier in this section of the preamble.) The Agency is declining to adopt Mr. Erga's proposal here for the same reasons. In addition, OSHA believes that it is important for the final rule to allow employers to set the same procedures for protecting pulling and tensioning equipment as they set for other types of mechanical equipment; the hazards, and the methods of protecting employees, are the same. The Agency declines to change the heading for this paragraph, as suggested by Mr. Erga, because this paragraph applies not only to pulling and tensioning equipment, but to conductors and cables as well. Therefore, OSHA adopted paragraph (b)(2) substantially as proposed. In the final rule, OSHA replaced the word "wire" with "conductor" for consistency, as proposed § 1926.964(b)(2) used these words interchangeably.

Mr. James Junga with Local 223 of the Utility Workers Union of America requested clarification of proposed paragraph (b)(2) as it applies to pulling underground cables up a pole (Ex. 0197). First, he asked if this provision addressed the stress that the pulling operation puts on the pole (*id.*). OSHA notes that it addressed these hazards in final paragraph (a)(2), which requires the employer to determine that elevated structures such as poles and towers are strong enough to withstand the stresses imposed by the work employees will perform. In making that determination, the employer must consider the stresses imposed by pulling underground cables up a pole.

Second, Mr. Junga asked whether paragraph (b)(2) applies to pulling operations when employees pull an underground cable up a pole between energized conductors. OSHA considers an underground cable-pulling operation to fall under the overhead line provisions whenever employees pull the "underground" cable up a pole or other overhead structure because the cable is an overhead line where the cable rises overhead. Thus, the precautions in final paragraph (b)(2) apply when employees pull an underground cable up a pole close enough to energized conductors that the specified failures could energize the pulling or tensioning equipment or the cable.

Paragraph (b)(3), which is being adopted without substantive change from the proposal, requires the disabling of the automatic-reclosing feature of the devices protecting any circuit for conductors energized at more than 600 volts and that pass under conductors employees are installing or removing. If the employer did not make the automatic-reclosing feature inoperable, it would cause the circuit protective devices to reenergize the circuit after they had tripped, exposing the employees to additional or more severe injury.

Final paragraph (b)(1) requires the use of techniques that minimize the possibility of contact between existing and new conductors. Final paragraph (b)(2) requires the use of measures that protect employees from hazardous differences in potential. These two paragraphs provide the primary protection to employees installing conductors. Final paragraph (b)(3) is a redundant form of protection; it provides an additional measure of safety in case the employer violates the first two provisions.[428] Therefore, this paragraph applies only to circuit reclosing devices designed to permit the disabling of the automatic-reclosing feature. The Agency believes that the

[428] Disabling the reclosing feature of circuit protective devices does not provide any protection against initial contact with the energized circuit involved. It only prevents the devices from reenergizing the circuit after they open it on a fault condition as would occur, for example, when a line an employee is stringing drops onto an energized conductor.

combination of final paragraphs (b)(1), (b)(2), and (b)(3) will provide effective protection to employees against the electrical hazards associated with installing or removing lines near energized parts.

OSHA proposed paragraph (b)(4) to protect workers from the hazard of induced voltage on lines they are installing near (and usually parallel to) other energized lines. Proposed paragraph (b)(4) contained supplemental provisions on grounding that would have applied, in addition to grounding requirements elsewhere in Subpart V. The proposed paragraph generally would have required employers to ground these lines to minimize the voltage and protect employees handling the lines from electric shock when there was a hazard from induced voltage.

Proposed paragraph (b)(4) provided that, before employees install lines parallel to existing energized lines, the employer would have to determine the approximate voltage to be induced in the new lines or assume that the induced voltage would be hazardous. Additionally, the proposal would have permitted employers to treat the line as energized rather than comply with the grounding requirements contained in proposed paragraph (b)(4). As proposed, paragraph (b)(4) contained five requirements that would have applied unless: (a) The employer could demonstrate that the lines being installed were not subject to the induction of hazardous voltage or (b) the lines were treated as energized. These provisions would have required employers to:

(1) Install grounds on each bare conductor in increments of no more than 2 miles (proposed paragraph (b)(4)(i));

(2) Ensure that grounds remain in place until completion of the installation between dead ends (proposed paragraph (b)(4)(ii));

(3) Remove grounds as the last phase of aerial cleanup (proposed paragraph (b)(4)(iii));

(4) Install grounds at each work location and at all open dead-end or catch-off points or the next adjacent structure when employees are working on bare conductors (proposed paragraph (b)(4)(iv)); and

(5) Bond and ground bare conductors before splicing them (proposed paragraph (b)(4)(v)).

Mr. Brian Erga with ESCI objected to the requirements in proposed paragraph (b)(4), maintaining that the proposed provisions had serious flaws that posed hazards to employees (Exs. 0155, 0471; Tr. 1254–1256). He proposed alternative provisions to protect workers installing lines from hazards associated with the lines becoming energized either through contact with energized parts or by electromagnetic or electrostatic induction (*id.*). He explained:

> [S]everal paragraphs in the current section of OSHA 1910.269(q) and the proposed section of OSHA 1926.964 are simply wrong and "old school." Much of the current and proposed regulations rely on theories and beliefs that have been found to be totally incorrect and in some cases deadly wrong.
>
> OSHA 1910.269(q)(2)(iv) and 1926.964(b)(4)(i) requires:
>
> (i) Each bare conductor shall be grounded in increments so that no point along the conductor is more than 3.22 km (2 miles) from a ground.
>
> (ii) If employees are working on bare conductors, grounds shall also be installed at each work location where these employees are working and grounds shall be installed at all open dead-ends or catch-off points or the next adjacent structure.
>
> OSHA 1926.964(b)(4)(i) through (b)(4)(iv) provides no protection and cannot be justified with today's knowledge of equipotential grounding procedures. These procedures are not supported in any industry published documents and contradicts IEEE 1048.
>
> . . . ESCI has yet to find an industry expert who can explain the reason for OSHA 1910.269(q)(2)(iv) and 1926.964(b)(4)(i). In fact these procedures create lethal hazards on de-energized lines and equipment for workers. Again, these rules are from the days when we believed in safety of "felt hats" and the "horse and buggy."
>
> Documented fatal accidents prove multiple sets of grounds on the same de-energized line can create electrostatic induction at lethal levels. On December 18, 2000, Connecticut Light and Power sustained a fatal accident when a qualified worker was electrocuted on a grounded static wire, of a de-energized and grounded line that was grounded in multiple locations along the lines route . . . .
>
> IEEE 1048–2003, Section 4.4.2 "Magnetic coupling under normal conditions" discusses the hazard developed by closing the station ground switches and installing grounds at the worksite (use of multiple grounds at multiple locations along the line). This hazard can be easily eliminated by grounding at one location; the worksite with [an equipotential zone].
>
> Other industry studies have shown that more than one personal protective ground, installed at the work location, does nothing but create additional hazards. [Ex. 0471]

Mr. Erga's comment convinced the Agency that multiple unnecessary grounds can lead to injury and that proposed paragraph (b)(4), which provided for multiple redundant grounds, is therefore insufficiently protective. Furthermore, OSHA notes that other provisions in the standard that require protective grounding impose performance requirements that protect employees from hazardous differences in potential. For example, final § 1926.962(c) requires temporary protective grounds to be placed on deenergized conductors to prevent employee exposure to hazardous differences in electric potential. Paragraph (d)(3)(iii) of final § 1926.959 requires employers to protect each employee from hazards that might arise from mechanical equipment's contacting energized lines, including protection from hazardous differences in electric potential. OSHA decided to adopt a similar provision here. First, the Agency divided paragraph (b)(4) of proposed § 1926.964 into two paragraphs. Final paragraph (b)(4)(i), which is described further later in this section of the preamble, contains the first sentence from the introductory text to proposed paragraph (b)(4) without substantive change. Paragraph (b)(4)(ii), which replaces the last sentence of the introductory text to proposed paragraph (b)(4) and proposed paragraphs (b)(4)(i) through (b)(4)(v), sets the employer's obligation to protect employees from hazardous differences in potential unless the lines employees are installing are not subject to the induction of a hazardous voltage or unless the lines are treated as energized. Paragraph (b)(4)(ii) of the final rule reads as follows:

> 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.

OSHA also added a note following this paragraph, similar to the notes to final §§ 1926.959(d)(3)(iii) and 1926.962(c), indicating that Appendix C contains guidelines for protecting employees from hazardous differences in electric potential.

OSHA decided against adopting Mr. Erga's suggested regulatory language. The Agency believes that his proposed language is too detailed and that the requirement adopted in the final rule appropriately states the objective in performance terms. OSHA, however, considered Mr. Erga's suggested requirements and adopted several of them as guidelines in Appendix C to final Subpart V for installing protective grounding equipment to protect employees from hazardous differences in potential.

As noted earlier, paragraphs (b)(4)(i) and (b)(4)(ii) of the final rule require the employer to determine whether existing energized lines will induce hazardous voltage when lines are installed parallel

to the existing lines. OSHA notes that the final rule does not provide specific guidance for determining whether a hazard exists due to induced voltage. The hazard depends not only on the voltage of the existing line, but also on the length of the line employees are installing and the distance between the existing line and the new one. Electric shock, whether caused by induced or other voltage, poses two different hazards. First, the electric shock could cause an involuntary reaction, which could cause a fall or other injury. Second, the electric shock itself could cause respiratory or cardiac arrest. 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. (The 500-ohm resistor represents the resistance of an employee. The 1 milliampere current is the threshold of perception.) 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 (the let-go threshold for women [429]). OSHA included a note to this effect following final paragraph (b)(4).

Paragraph (b)(5) of the final rule requires reel-handling equipment, including pulling and tensioning equipment, to be in safe operating condition, as well as leveled and aligned. Proper alignment of the stringing machines will help prevent failure of the equipment, conductors, and supporting structures, which could result in injury to workers. OSHA is adopting this provision without change from the proposal.

The purpose of final paragraphs (b)(6), (b)(7), and (b)(8) is to prevent failure of the line-pulling equipment and accessories. These provisions, respectively, require the employer to ensure that employees do not exceed load ratings (limits) of the equipment, require the repair or replacement of defective pulling lines and accessories, and prohibit the use of conductor grips on wire rope unless the manufacturer designed such grips specifically for use in pulling wire rope. OSHA considers equipment damaged beyond manufacturing specifications or damaged to an extent that would reduce its load ratings to be "defective" for the purposes of final paragraph (b)(7). Manufacturers normally provide load limits and design specifications, but employers also can find load limits and specifications in engineering and materials handbooks (see, for example, *The Lineman's and Cableman's Handbook,* 269-Ex. 8–5). OSHA adopted paragraphs (b)(6), (b)(7), and (b)(8) without substantive revision from the proposal.

When employers use the tension stringing method, the pulling rig (which takes up the pulling rope and thereby pulls the conductors into place) is separated from the reel stands and tensioner (which pay out the conductors and apply tension to them) by one or more spans (the distance between the structures supporting the conductors). In an emergency, the pulling equipment operator may have to shut down the operation. Paragraph (b)(9), which is being adopted without substantive change from the proposal, requires the employer to ensure that employees maintain reliable communication between the reel tender and the pulling-rig operator through two-way radios or other equivalent means. OSHA designed this provision to ensure that, in case of emergency at the conductor supply end, the pulling rig operator can shut the equipment down before injury-causing damage occurs.

Paragraph (b)(10), which is being adopted without substantive change from the proposal, prohibits the operation of the pulling rig under unsafe conditions. OSHA included an explanatory note following final paragraph (b)(10) providing examples of unsafe conditions.

Paragraph (b)(11), which is being adopted without substantive change from the proposal, generally prohibits employees from working directly beneath overhead operations or on the crossarm while a power-driven device is pulling the conductor or pulling line and the conductor or pulling line is in motion. Employees may perform work in such positions only as necessary to guide the stringing sock or board over or through the stringing sheave. This provision minimizes employee exposure to injury resulting from the failure of equipment, conductors, or supporting structures during pulling operations.

Under certain conditions, employees must perform work on transmission and distribution lines while they remain energized. Sometimes, employees use rubber insulating equipment or live-line tools to accomplish this work. However, this equipment has voltage and other limitations which make it impossible to insulate the employee performing work on energized lines under all conditions. In such cases, usually on medium- and high-voltage transmission lines, employees use the live-line barehand technique to perform the work. When they perform work "bare handed," the employees work from an insulated aerial platform and are electrically bonded to the energized line. In this configuration, there is essentially no potential difference across the worker's body, thereby protecting the employee from electric shock. Final paragraph (c) addresses the live-line barehand technique.

OSHA took paragraph (c) from existing § 1910.269(q)(3). Existing § 1926.955(e) contains similar requirements for live-line bare hand work. The following summary and explanation of final § 1926.964(c) outlines the substantive differences between this final rule and the existing rules.

Because employees perform live-line barehand work on overhead lines, OSHA proposed to place requirements for this type of work in the section relating to work on overhead lines. This placement is consistent with the placement of live-line barehand requirements in existing Subpart V. However, it is technically possible to perform live-line barehand work on other types of installations as well (in substations, for example). In the preamble to the proposal, OSHA requested comments on whether it should consolidate the live-line barehand requirements with the other requirements relating to work on energized lines contained in § 1926.960.

OSHA received few comments on this issue. Most of the commenters recommended leaving the live-line barehand requirements in the section on overhead line work. (See, for example, Exs. 0162, 0186, 0227.) TVA recommended moving the live-line bare hand requirements to § 1926.960 to place all requirements related to work on energized lines in one location (Ex. 0213). BGE recommended that the live-line barehand requirements stand alone (Ex. 0126).

OSHA decided to keep the live-line barehand provisions with the requirements for overhead line work. The Agency believes that nearly all live-line barehand work is performed on overhead lines. In addition, the inherent characteristics of the work and the required minimum approach distances to grounded objects generally make it difficult to use the live-line barehand technique on energized parts not

[429] 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, there are accepted values for women, men, and children. At 6 milliamperes, 5 percent of women will not be able to let go. Thus, this is the accepted let-go threshold for women. (See 41 FR 55698.)

installed overhead. However, OSHA is making changes to § 1926.964 to clarify that paragraph (c) applies to all barehand work on energized parts. The Agency is modifying the title of final § 1926.964 and the scope of this section, as set forth in paragraph (a)(1), to indicate that this section applies to live-line barehand work, in addition to overhead line work. Thus, final paragraph (c) applies to live-line barehand work irrespective of whether employees perform this work on overhead lines.

Final paragraph (c)(1) requires employers to train each employee using, or supervising the use of, the live-line barehand method on energized circuits in the technique and safety requirements of final § 1926.964(c). The training must conform to § 1926.950(b). Without this training, employees would not be able to perform this highly specialized work safely. Proposed paragraph (c)(1) incorrectly implied that only refresher training needed to meet proposed § 1926.950(b). OSHA revised the language in this provision in the final rule to make it clear that the employee must complete training conforming to final § 1926.950(b) and that all of the training requirements in § 1926.950(b) apply.

Before employees can start live-line barehand work, employers must ascertain the voltage of the lines on which employees will be performing work. This voltage determines the minimum approach distances and the types of equipment that employees can use. If the voltage is higher than expected, the minimum approach distance will be too small, and the equipment may not be safe for use. Therefore, final paragraph (c)(2) requires employers to make a determination, before any employee uses the live-line barehand technique on energized high-voltage conductors or parts, of the nominal voltage rating of the circuit, of the clearances to ground of lines and other energized parts on which employees will perform work, and of the voltage limitations of equipment they will be using. OSHA is adopting this provision largely as proposed. The Agency describes two key revisions in the following paragraph.

First, the final rule clarifies that this information is in addition to the information about existing conditions that is required by final § 1926.950(d). Second, final § 1926.964(c)(2)(ii) uses the term "clearances to ground" in place of the proposed term "minimum approach distances to ground." OSHA took this provision from existing § 1910.269(q)(3)(ii)(B). OSHA took existing § 1910.269(q)(3)(ii)(B), in turn, from existing § 1926.955(e)(2)(ii), which uses the term "clearances to ground." [430]

The term "clearances to ground" in existing § 1926.955(e)(2)(ii) refers to the clear distance between energized parts and ground. That term, not "minimum approach distances to ground," is appropriate here. Therefore, in final § 1926.964(c)(2)(ii), OSHA is adopting the term from existing § 1926.955(e)(2)(ii) in place of the proposed term.

Because an employee performing live-line barehand work is at the same potential as the line on which he or she is working, the employee has exposure to two different voltages. First, the employee is exposed to the phase-to-ground voltage with respect to any grounded object, such as a pole or tower. Second, the employee is exposed to the full phase-to-phase voltage with respect to the other phases on the circuit. Thus, there are two sets of minimum approach distances applicable to live-line barehand work—one for the phase-to-ground exposure (the distance from the employee to a grounded object) and one for the phase-to-phase exposure (the distance from the employee to another phase). The phase-to-phase voltage is higher than the phase-to-ground voltage. Consequently, the phase-to-phase-based minimum approach distance is greater than the phase-to-ground-based minimum approach distance. (See the explanation of the basis for minimum approach distances in the summary and explanation for final § 1926.960(c)(1), earlier in this section of the preamble.)

Paragraph (c)(3)(i), which is being adopted without substantive change from the proposal, requires that the employer ensure that the insulated tools (such as live-line tools), insulated equipment (such as insulated ladders), and aerial devices and platforms used by employees in live-line barehand work are designed, tested, and made for live-line barehand work. The Agency considers insulated equipment (such as live-line tools) designed for long-duration contact with parts energized at the voltage on which employees will use the equipment to meet this requirement. Insulating equipment designed for brush contact only is not suitable for live-line barehand work. Paragraph (c)(3)(ii), which is being adopted without substantive change from the proposal, requires that employers ensure that employees keep tools and equipment clean and dry while they are in use. These provisions are important to ensure that equipment does not fail under constant contact with high-voltage sources.

Paragraph (c)(4), which is being adopted without substantive change from the proposal, requires employers to render inoperable the automatic-reclosing feature of circuit-interrupting devices protecting the lines if the design of those devices so permits. In case of a fault at the worksite, it is important for the circuit to be deenergized as quickly as possible and for it to remain deenergized once the protective devices open the circuit.[431] Preventing the reclosing of a circuit will reduce the severity of any possible injuries. Additionally, this measure helps limit possible switching-surge voltage, thereby providing an extra measure of safety for employees. This provision is comparable to existing § 1926.955(e)(5), which requires the employer to render the automatic-reclosing feature inoperable "where practical." The proposal eliminates this phrase because OSHA believes that it is essential that a line that becomes deenergized on a fault not be reenergized if possible. During live-line barehand work, employees have no other back-up system providing for their safety as they would for work on deenergized lines.[432] Thus, if the employee causes a fault on the line, the line must not become reenergized automatically.

Sometimes the weather makes live-line barehand work unsafe. For example, lightning strikes on lines can create severe transient voltages against which the minimum approach distances required by final paragraph (c)(13) (described later in this section of the preamble) may not provide complete protection to employees working on the line. Additionally, forces imposed by the wind can move line conductors and reduce the clearance below the minimum approach distance. To provide protection against environmental conditions that can increase the hazards by an unacceptable degree, final paragraph (c)(5) prohibits live-line barehand work under adverse weather conditions that make the work

[430] In fact, in 1989, OSHA used "clearances to ground" in proposed § 1910.269(q)(3)(ii)(B). The Agency mistakenly changed the language from "clearances to ground" to "minimum approach distances to ground" in the 1994 final rule promulgating § 1910.269 because OSHA decided to replace the term "clearance" with "minimum approach distance" throughout § 1910.269 where it used the word "clearances" to refer to "[t]he closest distance an employee is permitted to approach an energized or a grounded object" (59 FR 4381).

[431] If the circuit protective devices do not provide an autoreclosing feature, the circuit will remain deenergized by design. In addition, voltage surges caused by circuit reclosing would not occur.

[432] Protective grounding provides supplementary protection in case the deenergized line is reenergized.

hazardous even after the employer implements the work practices required by Subpart V. Also, employees may not work under any conditions in which winds reduce phase-to-phase or phase-to-ground clearances at the work location below the minimum approach distances specified in final paragraph (c)(13), unless insulating guards cover the grounded objects and other lines and equipment.

Existing § 1926.955(e)(6) prohibits live-line barehand work only during electrical storms. OSHA believes that expanding the prohibition to include any weather condition making it unsafe to perform this type of work will increase employee protection. OSHA took the language for paragraph (c)(5) in the final rule from existing § 1910.269(q)(3)(v), which prohibits live-line barehand work "when adverse weather conditions would make the work hazardous even after the work practices required by *this section* are employed." (Emphasis added.) OSHA included this language in proposed § 1926.964(c)(5). The Agency corrected paragraph (c)(5) in the final rule by replacing the word "section" with "subpart." In addition, the Agency revised this provision in the final rule to clarify that employees may not perform work when winds reduce the phase-to-ground or phase-to-phase *clearances* (rather than "minimum approach distances") below the required minimum approach distances.

A note to final paragraph (c)(5) provides that 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 Subpart V. In the final rule, OSHA revised the note from the proposal to more closely match the regulatory text in paragraph (c)(5). In addition, the Agency changed "immediate vicinity" to "vicinity" to clearly indicate that thunderstorms do not need to be in the work area to pose hazards.[433]

Paragraph (c)(6), which is being adopted without substantive change from the proposal, requires the use of a conductive device, usually a conductive bucket liner, for bonding the insulated aerial device to the energized line or equipment. This bond creates an area of equipotential in which the employee can work safely. The employee must be bonded to this device by means of conductive shoes or leg clips or by another effective method. Additionally, if necessary to protect employees further (that is, if differences in electric potential at the worksite pose a hazard to employees), the employer must provide electrostatic shielding designed for the voltage. This paragraph, which OSHA took from existing § 1910.269(q)(3)(vi), is essentially identical to existing § 1926.955(e)(7).

To avoid receiving a shock caused by charging current, the employee must bond the conductive bucket liner or other conductive device to the energized conductor before he or she touches the conductor. Typically, employees use a live-line tool to bring a bonding jumper (already connected to the conductive bucket liner) into contact with the energized line. This connection brings the equipotential area surrounding the employee to the same voltage as that of the line. Thus, paragraph (c)(7), which is being adopted without substantive change from the proposal, requires the employer to 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. Final paragraph (c)(7) also requires this connection to remain attached to the energized conductor until employees complete the work on the energized circuit. This paragraph, which OSHA took from existing § 1910.269(q)(3)(vii), is essentially identical to existing § 1926.955(e)(14).

Paragraph (c)(8), which is being adopted without substantive change from the proposal, requires aerial lifts used for live-line barehand work to have upper controls that are within easy reach of the employee in the bucket and lower controls near the base of the boom that can override operation of the equipment. On two-bucket-type lifts, the upper controls must be within easy reach of both buckets. Upper controls are necessary so that employees in the bucket can precisely control the lift's direction and speed of approach to the live line. Control by workers on the ground responding to directions from a worker in the bucket could lead to contact by an employee in the lift with the energized conductor before the bonding jumper is in place. Controls are necessary at ground level, however, so that employees on the ground can promptly lower and assist employees in the lift who become disabled as a result of an accident or illness. Therefore, paragraph (c)(9), which is being adopted without substantive change from the proposal, prohibits, except in an emergency, operation of the ground-level controls when an employee is in the lift. Final paragraphs (c)(8) and (c)(9), which OSHA took from existing § 1910.269(q)(3)(viii) and (q)(3)(ix), respectively, are essentially identical to existing § 1926.955(e)(12) and (e)(13).

Paragraph (c)(10), which is being adopted without substantive change from the proposal, requires the employer to ensure that employees check all aerial-lift controls to ensure that they are in proper working order before employees elevate an aerial lift into the work position. This paragraph, which OSHA took from existing § 1910.269(q)(3)(x), is essentially identical to existing § 1926.955(e)(10).

To protect employees on the ground from the electric shock they would receive upon touching the truck supporting the aerial lift, paragraph (c)(11), which is being adopted without substantive change from the proposal, requires the body of the truck to be grounded, or the body of the truck to be barricaded and treated as energized, before employees elevate the boom. If the truck is grounded, the insulation of the lift limits the voltage on the body of the truck to a safe level. This paragraph, which OSHA took from existing § 1910.269(q)(3)(xi), is similar to existing § 1926.955(e)(9). The existing requirement in Subpart V, however, also includes a provision for using the outriggers on the aerial lift to stabilize the equipment. Final § 1926.959(b), discussed earlier in this section of the preamble, addresses the need to stabilize aerial lifts.

Aerial lifts that are used in live-line barehand work are exposed to the full line-to-ground voltage of the circuit for the duration of the job. To ensure that the insulating value of the lift being used is high enough to protect employees, final paragraph (c)(12) requires the employer to ensure that employees perform a boom-current test before starting work each day. Employers also must ensure that employees perform the test each time during the day when they encounter a higher voltage and whenever changed conditions indicate a need for retesting.

According to final paragraph (c)(12)(i), the test consists of placing the bucket in contact with a source of voltage equal to that encountered during the job and keeping it there for at least 3 minutes. Employees normally accomplish the test at the worksite by placing the bucket in contact with the energized line on which they will be working (without anybody in the bucket, of course).

To provide employees with a level of protection equivalent to that provided by existing § 1910.269(q)(3)(xii) and

[433] Section 7.3.1.1 of IEEE Std 516–2009 states: "Energized-line maintenance should not be started when lightning is visible or thunder is audible at the worksite" (Ex. 0532).

American National Standard for Vehicle-Mounted Elevating and Rotating Aerial Devices (ANSI/SIA A92.2–2001 [434]), OSHA proposed, in the third sentence of paragraph (c)(12), to permit a leakage current of up to 1 microampere per kilovolt of nominal phase-to-ground voltage. In contrast, the corresponding provision in existing § 1926.955(e)(11) is less protective; it allows up to 1 microampere of current for every kilovolt of phase-to-phase voltage.[435] OSHA received no comments on this issue and, therefore, adopted the proposed limit of 1 microampere per kilovolt of nominal phase-to-ground voltage in paragraph (c)(12)(ii) of the final rule.

Final paragraph (c)(12)(iii) requires the immediate suspension of work from the aerial lift whenever there is an indication of a malfunction of the equipment, not only during tests. This requirement will prevent the failure of insulated aerial devices during use and will only affect work from an aerial lift. Employers may continue work not involving an aerial lift. Halting work from the lift will protect employees in the lift, as well as employees on the ground, from the electrical hazards involved.

OSHA took paragraph (c)(12) from existing § 1910.269(q)(3)(xii) and adopted paragraph (c)(12) without substantive change from the proposal; this provision in the final rule is similar to existing § 1926.955(e)(11), except as previously noted.

Paragraphs (c)(13), (c)(14), and (c)(15) in the proposed rule would have generally required employees to maintain the minimum approach distances specified in Table V–2 through Table V–6 from grounded objects and from objects at an electric potential different from the potential of the bucket. Those proposed provisions, which OSHA based on existing § 1910.269(q)(3)(xiii), (q)(3)(xiv), and (q)(3)(xv), were essentially identical to existing § 1926.955(e)(15), (e)(16), and (e)(17). Proposed paragraph (c)(13) applied to minimum approach distances in general; proposed paragraph (c)(14) covered minimum approach distances for employees approaching or leaving the energized conductor or bonding to an energized circuit; and proposed paragraph (c)(15) applied to the distance between the bucket and the grounded end of a bushing or insulator string and other grounded surfaces. The latter two paragraphs in the proposal clarified that the employee and the bucket are, in effect, at phase potential as the employee is approaching the energized part and that employees would have to maintain the phase-to-ground minimum approach distance from grounded objects. The preamble to the proposal noted that the employee also would have to maintain the phase-to-phase minimum approach distance from the other phases on the system (70 FR 34882) and requested comments on whether proposed paragraphs (c)(14) and (c)(15) should address objects at different phase potentials, in addition to objects at ground potential.

Only two commenters addressed this issue. BGE commented that it is reasonable to address only phase-to-ground potential because the proposed provisions implied phase-to-phase potential (Ex. 0126). IBEW argued, in contrast, that OSHA also should address phase-to-phase exposures in paragraphs (c)(14) and (c)(15), commenting:

> Since this requirement is contained in the live-line bare-hand work section of the proposal, the language should address objects at different phase potential, not just ground potentials. When performing live-line bare-hand work mid span, the phase-to-phase MAD could be critical. The same would hold true anytime an aerial device would be positioned between dead-ends on structures, or any other configuration when multiphases are present on the structure. [Ex. 0230]

OSHA decided to take a middle course on this issue. When an employee is working at phase potential, which final paragraph (c)(13) covers, or moving into or away from the working position, which final paragraph (c)(14) covers, both phase-to-phase and phase-to-ground exposures may come into play. Proposed paragraph (c)(13) addressed both exposures, but, as noted in the preamble to the proposal, proposed paragraph (c)(14) did not (70 FR 34882). OSHA is correcting this oversight in the final rule, so that final paragraph (c)(14) also requires the employer to ensure that employees maintain the minimum approach distances "between the employee and conductive objects energized at different potentials."

Proposed paragraph (c)(15) supplemented proposed paragraphs (c)(13) and (c)(14) and served as a reminder that the phase-to-ground minimum approach distance applied to the grounded end of the insulator string. Thus, there is no need to add phase-to-phase exposures to this paragraph.

OSHA is making an additional change to paragraphs (c)(13) through (c)(15) to account for changes in the minimum approach-distance requirements adopted in final § 1926.960(c)(1). The final rule does not list specific minimum approach distances in tables as the proposal did. Instead, final § 1926.960(c)(1)(i) requires the employer to establish minimum approach distances. (See the summary and explanation for final § 1926.960(c)(1), earlier in this section of the preamble.) Consequently, paragraphs (c)(13) through (c)(15) of final § 1926.964 refer to "minimum approach distances, established by the employer under § 1926.960(c)(1)(i)," in place of the references to proposed Table V–2 through Table V–6.

Mr. Anthony Ahern with Ohio Rural Electric Cooperatives noted that clearances between phases in substations typically are closer than on power lines (Ex. 0186). He asserted that if paragraph (c) "is also going to cover bare hand work in substations then phase to phase clearances also need to be addressed" (*id.*).

OSHA does not dispute Mr. Ahern's assertion that phase-to-phase clearances in substations may be smaller than on overhead lines. However, if the clearances are too small to permit employees to maintain minimum approach distances for phase-to-phase exposures while performing live-line barehand work, then the employer will have to choose a different work method. The Agency notes that employers already face this issue under existing § 1910.269 and Subpart V, which both set minimum approach distances for phase-to-phase exposures.

Paragraph (c)(16), which is being adopted without substantive change from the proposal, prohibits the use of handlines between the bucket and boom or between the bucket and ground. Such use of lines could result in a potential difference between the employee in the bucket and the power line when the employee contacts the handline. If the handline is a nonconductive type not supported from the bucket, employees may use it from the conductor to ground. (Unless the rope is insulated for the voltage, employees on the ground must treat it as energized.[436]) Lastly, the employer must ensure that no one uses

[434] The 2009 edition of ANSI/SIA A92.2 contains an identical requirement.

[435] For a three-phase, Y-connected system, the phase-to-phase voltage equals times the phase-to-ground voltage.

[436] The definition of "insulated" in final § 1926.968 reads: "Separated from other conducting surfaces by a dielectric (including air space) offering a high resistance to the passage of current." The note following this definition states: "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." Thus, employees must treat any rope not insulated for the voltage as a conductive object and, thus, as energized when it is in contact with an energized part.

ropes used for live-line barehand work for other purposes.

OSHA took final paragraph (c)(16) from existing § 1910.269(q)(3)(xvi); this provision is similar to existing § 1926.955(e)(18). However, the existing standard, at § 1926.955(e)(18)(ii), prohibits employees from placing conductive materials over 36 inches long in the aerial lift bucket. Existing § 1926.955(e)(18)(ii) makes exceptions for "appropriate length jumpers, armor rods, and tools." OSHA is removing this requirement. Under the final rule, employers must ensure that employees maintain minimum approach distances regardless of the length of any conductive object. Thus, existing § 1926.955(e)(18)(ii) is unnecessary.

Paragraph (c)(17), which is being adopted without substantive change from the proposal, prohibits passing uninsulated equipment or materials between a pole or structure and an aerial lift while an employee working from the bucket is bonded to an energized part. Passing uninsulated objects in this way would bridge the insulation to ground and endanger the employee. This provision, which OSHA based on existing § 1910.269(q)(3)(xvii), has no counterpart in existing § 1926.955(e).

Proposed paragraph (c)(18) would have required the employer to print, on a plate of durable nonconductive material, a table reflecting the minimum approach distances listed in proposed Table V–2 through Table V–6. That paragraph would also have required the employer to mount the plate so as to be visible to the operator of the boom on aerial devices used for live-line barehand work. This provision, which OSHA took from existing § 1910.269(q)(3)(xviii), was equivalent to existing § 1926.955(e)(20)(i).

Although the Agency received no comments on this proposed provision, OSHA is not including it in the final rule. First, the final rule replaces the tables specifying minimum approach distances with a requirement that the employer establish minimum approach distances based on formulas. For voltages over 72.5 kilovolts, where employers use the live-line barehand technique, those established minimum approach distances could vary from site to site as the maximum transient overvoltage varies.[437] Employers would comply with proposed paragraph (c)(18) with a table listing either a single minimum approach distance for each voltage or listing a variety of minimum approach distances for each voltage. A table listing a single value for each voltage would list minimum approach distances that employees would not be using at some sites, possibly leading to confusion. A table listing a variety of minimum approach distances for each voltage would be more difficult for employees to follow and might lead them to use noncompliant minimum approach distances, thus exposing the employees to sparkover hazards.

Second, with information provided by the employer under final §§ 1926.950(d) and 1926.952(a)(1), employees will know the applicable minimum approach distance and will discuss it during the job briefing required under final § 1926.952(a)(2). Through the job briefing, the aerial device operator, and, if needed, the observer required under § 1926.959(d)(2), will know the applicable minimum approach distance without needing to reference a table mounted on the boom of the aerial device.

For these reasons, OSHA is not adopting proposed § 1926.964(c)(18) in the final rule.

Final paragraph (c)(18) requires a nonconductive measuring device to be available and readily accessible to employees performing live-line barehand work. OSHA took this provision from existing § 1910.269(q)(3)(xix). Existing § 1926.955(e)(20)(ii) recommends, but does not require, an insulating measuring device. OSHA believes that this should be a requirement, rather than a recommendation, so that employees can accurately determine whether they are maintaining the required minimum approach distances. Compliance with final paragraph (c)(18) will help the employee accurately determine and maintain the minimum approach distances required by the standard. OSHA revised paragraph (c)(18) in the final rule to clarify that the measuring device must be accessible to employees performing live-line barehand work.

Existing § 1926.955(e)(19) prohibits employees from overstressing an aerial lift used in live-line barehand work while lifting or supporting weights. OSHA did not include this requirement in proposed or final § 1926.964. The hazard addressed by the existing requirement is a general hazard, which is present whenever an employee uses an aerial lift, not just during live-line barehand work. Final § 1926.959(c), which requires employers to operate mechanical equipment within its maximum load ratings and other design limitations, is the appropriate provision addressing the relevant hazards.

Final paragraph (d) addresses hazards associated with towers and other structures supporting overhead lines. OSHA took this paragraph from existing § 1910.269(q)(4).

Paragraph (b) of existing § 1926.955 addresses metal tower construction. Many of the requirements in the existing rules cover the same hazards as other provisions in the construction standards. For example, existing § 1926.955(b)(1), (b)(2), and (b)(3) address hazards associated with footing excavations. Subpart P of Part 1926 fully protects power transmission and distribution workers from these hazards.[438] Therefore, revised Subpart V contains no counterparts to these existing requirements. Existing § 1926.955(b)(5)(i) and (b)(7) contain simple references to other Part 1926 requirements. Existing § 1926.955(b)(5)(iii), (b)(6)(i), (b)(6)(v), and (b)(8), which address a few of the hazards associated with mechanical equipment, contain requirements that are equivalent to provisions in existing Subpart CC of Part 1926 or final § 1926.959. Revised Subpart V does not contain counterparts for these six paragraphs. OSHA believes that eliminating these provisions will reduce redundancy and will eliminate the potential for conflicts between different standards. No rulemaking participants opposed the removal of these existing requirements.

To protect employees on the ground from hazards presented by falling objects, paragraph (d)(1), which is being adopted without substantive change from the proposal, prohibits workers from standing under a tower or other structure while work is in progress, unless the employer can demonstrate that their presence is necessary to assist employees working above. This provision, which OSHA took from existing § 1910.269(q)(4)(i), is equivalent

[437] The final rule does not require the employer to make site-by-site engineering analyses. The employer could make an analysis that applies to a single site, a range of sites, or all sites for a given voltage, depending on the approach the employer takes in performing the engineering analysis. See the summary and explanation for final § 1926.960(c)(1)(ii), earlier in this section of the preamble.

[438] Provisions outside Subpart P cover two of the requirements in the existing paragraphs. Under the last sentence of existing § 1926.955(b)(1), employees must use ladders to access pad- or pile-type footing excavations more than 4 feet deep. Paragraph (a) of § 1926.1051 already addresses this hazard; this provision requires employers to provide a stairway or a ladder for access to breaks in elevation of more than 48 cm, unless a ramp, runway, sloped embankment, or personnel hoist is available. Existing § 1926.955(b)(3)(iii) addresses the stability of equipment used near excavations. Final § 1926.959(b) and (c) cover hazards associated with instability of mechanical equipment.

to existing § 1926.955(b)(4)(i) and (b)(5)(ii). However, final paragraph (d)(1) eliminates the redundancy presented by the two existing requirements in § 1926.955.

Paragraph (d)(2), which is being adopted without substantive change from the proposal, requires the employer to 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 result in a greater hazard to employees. The use of tag lines prevents moving tower sections from striking employees. This provision, which OSHA took from existing § 1910.269(q)(4)(ii), is similar to existing § 1926.955(b)(4)(ii) and (b)(6)(ii). However, final paragraph (d)(2) eliminates the redundancy presented by the two existing requirements in § 1926.955.

Paragraph (d)(3), which is being adopted without substantive change from the proposal, requires loadlines to remain in place until employees safely secure the load so that it cannot topple and injure an employee. This provision, which OSHA took from existing § 1910.269(q)(4)(iii), is essentially identical to existing § 1926.955(b)(4)(iii) and (b)(6)(iii). However, final paragraph (d)(3) eliminates the redundancy presented by the two existing requirements in § 1926.955.

Some weather conditions can increase the hazard for employees working from towers and other overhead structures. For example, icy conditions may increase the likelihood of slips and falls, perhaps making them unavoidable. Final paragraph (d)(4) generally provides that work must stop when adverse weather conditions make the work hazardous in spite of compliance with other applicable provision of Subpart V. However, when the work involves emergency restoration of electric power,[439] the additional risk may be necessary for public safety, and the standard permits employees to perform such work even in adverse weather conditions. This provision, which OSHA took from existing § 1910.269(q)(4)(iv), is essentially identical to existing § 1926.955(b)(6)(iv). OSHA changed "this section" in proposed paragraph (d)(4) to "this subpart" in final paragraph (d)(4) to accurately identify the CFR unit involved.

A note to paragraph (d)(4) provides that thunderstorms in the vicinity, high winds, snow storms, and ice storms are examples of adverse weather conditions that make work on towers or other structures that support overhead lines too hazardous to perform, even after the employee implements the work practices required by final Subpart V. In the final rule, OSHA revised the note to closely match the regulatory text in paragraph (d)(4). In addition, the Agency changed "immediate vicinity" to "vicinity" to more clearly indicate that thunderstorms do not need to be in the work area to pose a hazard.[440]

16. Section 1926.965, Underground Electrical Installations

In many electric distribution systems, utilities install electric equipment in enclosures, such as manholes and vaults, set beneath the earth. Section 1926.965 addresses safety for these underground electrical installations. As noted in final paragraph (a), the requirements in this section are in addition to requirements contained elsewhere in Subpart V (and elsewhere in Part 1926) because § 1926.965 only addresses conditions unique to underground facilities. For example, final § 1926.953, relating to enclosed spaces, also applies to underground operations involving entry into an enclosed space.

OSHA took § 1926.965 from existing § 1910.269(t). Existing Subpart V contains requirements for work on underground lines in § 1926.956. OSHA explains the differences between the existing rules and the final rule in the following summary and explanation of final § 1926.965.

Paragraph (b), which is being adopted without substantive change from the proposal, requires the use of ladders or other climbing devices for entrance into, and exit from, manholes and subsurface vaults that are more than 1.22 meters (4 feet) deep. Because employees' jumping into subsurface enclosures or climbing on the cables and hangers installed in these enclosures can easily injure employees, the standard requires the use of appropriate devices for employees entering and exiting manholes and vaults. Paragraph (b) specifically prohibits employees from climbing on cables and cable hangers to get into or out of a manhole or vault. OSHA took this provision from existing § 1910.269(t)(1). Existing Subpart V contains no counterpart to this requirement.

Paragraph (c), which is being adopted without substantive change from the proposal, requires equipment used to lower materials and tools into manholes or vaults to be capable of supporting the weight of the materials and tools and specifies that employers check this equipment for defects before employees use it. Paragraph (c) also requires employees to be clear of the area directly under the opening for the manhole or vault before tools or materials are lowered into the enclosure. These provisions, found in separate paragraphs in the final rule, protect employees against injuries from falling tools and material. Note that, because work addressed by this paragraph exposes employees to the danger of head injury, § 1926.100(a) requires employees to wear head protection when they are working in underground electrical installations. OSHA took paragraph (c) of the final rule from existing § 1910.269(t)(2). Existing Subpart V contains no counterpart to this requirement.

Final paragraph (d) requires attendants for manholes and vaults. Under final paragraph (d)(1), during the time employees are performing work in a manhole or vault that contains energized electric equipment, an employee with first-aid training must be available on the surface in the immediate vicinity[441] of the manhole or vault entrance (but not normally in the manhole or vault) to render emergency assistance. However, under paragraph (d)(2), the attendant may enter the manhole, for brief periods, to provide nonemergency assistance to the employees inside.

The provisions in final paragraph (d) ensure that employers can provide emergency assistance to employees working in manholes and vaults, where the employees work unobserved and where undetected injury could occur. Taken from existing § 1910.269(t)(3) and existing § 1926.956(b)(1), these requirements protect employees within the manholes and vaults without exposing the attendants outside to a risk of injury faced by employees inside these structures.

Because the hazards addressed by final paragraph (d) involve primarily electric shock, allowing the attendant to

[439] For purposes of final paragraph (d)(4), OSHA considers emergency-restoration work to be work needed to restore an electric power transmission or distribution installation to an operating condition to the extent necessary to safeguard the general public.

[440] Section 7.3.1.1 of IEEE Std 516–2009 states: "Energized-line maintenance should not be started when lightning is visible or thunder is audible at the worksite" (Ex. 0532).

[441] For the purposes of final § 1926.965(d)(1), "immediate vicinity" means near enough to the manhole or vault opening that the attendant can monitor employees in the space and render any necessary assistance in an emergency.

enter the manhole briefly[442] would have no significant effect on the safety of the employee he or she is protecting. In case of electric shock, the attendant would still be able to provide assistance. OSHA is adopting paragraph (d) without substantive change from the proposed rule. As noted in the summary and explanation for final §§ 1926.951(b) and 1926.953(h) earlier in this section of the preamble, OSHA adopted a definition of "first-aid training" that provides that first-aid training includes training in CPR. Therefore, OSHA replaced the term "first aid and CPR training meeting § 1926.951(b)(1)" in proposed § 1926.965(d)(1) with "first-aid training" in final § 1926.965(d)(1).

Mr. Kevin Taylor with Lyondell Chemical Company requested that the Agency clarify what this provision means by "immediate vicinity," asking: "Would this definition include someone in a nearby control room that is readily available (via radio) to come and administer CPR or first aid?" (Ex. 0218).

Final § 1926.968 defines "attendant" as "[a]n employee assigned to remain immediately outside the entrance to an enclosed or other space to render assistance as needed to employees inside the space." An employee in a control room is not close enough to the manhole or vault to qualify as an attendant for the purposes of the final rule.

As previously noted, final paragraph (d)(2) permits the attendant to occasionally enter the manhole or vault for brief periods to provide assistance for nonemergency purposes. Note that, if hazards other than electric shock could endanger the employee in the manhole or vault, final § 1926.953(h) also may apply. Paragraph (h) in final § 1926.953 requires attendants when employees are working in an enclosed space (which includes, manholes and vaults) and traffic patterns present a hazard in the area of the opening to the enclosed space. In such situations, having an attendant enter the manhole or vault would expose the attendant and the entrant to the traffic-pattern hazards. Therefore, the final rule does not permit attendants required under § 1926.953(h) to enter a manhole or vault. To clarify the application of the two different attendant requirements, OSHA included a note following final § 1926.965(d)(2). The note states that § 1926.953(h) may also require an attendant and does not permit this attendant to enter the manhole or vault.

OSHA included a second note following final paragraph (d)(2). The second note serves as a reminder that § 1926.960(b)(1)(ii) prohibits unqualified employees from working in areas containing unguarded, uninsulated energized lines or parts of equipment operating at 50 volts or more.

Mr. Lee Marchessault with Workplace Safety Solutions maintained that there was a conflict between proposed § 1926.953 and § 1926.965 with respect to the requirements for attendants (Ex. 0196; Tr. 580–581). He also recommended that OSHA revise § 1926.965(d)(2) to permit the attendant to enter a manhole or vault only when it is less than 1.5 meters (5 feet) in depth (Ex. 0196).

OSHA does not believe that the depth of a manhole or vault is generally relevant to determining whether an employer should permit an attendant to enter one of these spaces. If the depth of the manhole or vault presents a hazard, as it might if it were deep enough to pose pressure or access and egress hazards, then those hazards would still endanger the life of an entrant or interfere with escape from the space even after the employer takes the precautions required by final §§ 1926.953 and 1926.965. In such cases, final § 1926.953(a) would require entries to conform to paragraphs (d) through (k) of § 1910.146. Otherwise, the hazards for the entrant and attendant should be independent of the depth of the manhole or vault.

Moreover, the Agency does not believe that there is a conflict between the requirements for attendants in final §§ 1926.953 and 1926.965. As noted earlier, final § 1926.953(h) requires attendants for work in an enclosed space (which includes, manholes and vaults) if a hazard exists because of traffic patterns in the area of the opening to the enclosed space. Thus, this attendant requirement addresses hazards outside the space. On the other hand, the hazards addressed by final § 1926.965(d) primarily involve electric shock. As noted earlier, allowing the attendant required by this paragraph to enter the manhole or vault briefly has no significant effect on the safety of the employee he or she is protecting.

Paragraph (d)(3), which is being adopted without change from the proposal, permits an employee working alone to enter a manhole or vault, where energized cables or equipment are in service, for brief periods of time for the purpose of inspection, housekeeping, taking readings, or similar work. In such situations, the employer must demonstrate that the employee will be protected from all electrical hazards.

Mr. Lee Marchessault of Workplace Safety Solutions recommended that OSHA remove this paragraph from the standard (Ex. 0196; Tr. 581). He testified that "[t]here is no way to ensure the safety of a worker in a vault containing energized cables, and an attendant should always be prepared for rescue in case of emergency" (Tr. 581).

As noted earlier, the purpose of requiring an attendant under final paragraph (d) is to provide assistance in case the employee in the manhole or vault receives an electric shock. In proposing paragraph (d)(3), OSHA believed that, when an employee is performing the types of work listed in this provision, there is very little chance that he or she would suffer an electric shock. Mr. Marchessault did not provide any evidence that the permitted types of work are unsafe or that they expose employees to a risk of electric shock. In fact, final paragraph (d)(3) requires the employer to demonstrate that the employee will be protected from all electrical hazards. Thus, the Agency continues to believe it is safe for an employee to perform duties such as housekeeping and inspection without the presence of an attendant in the circumstances described by final paragraph (d)(3).

NIOSH recommended that this provision require the employer to demonstrate that employees will also be protected from "hazardous atmospheres (as required in 1910.146)" (Ex. 0130).

OSHA agrees that employees entering manholes and vaults may be exposed to hazardous atmospheres. However, these hazards are adequately addressed by the requirements on enclosed spaces contained in final § 1926.953, which also apply to manholes and vaults. Consequently, the Agency is not adopting the recommendation from NIOSH.

Paragraph (d)(4), which is being adopted without substantive change from the proposal, requires reliable communications through two-way radios or other equivalent means to be maintained among all employees involved in the job, including any attendants, the employees in the manhole or vault, and employees in separate manholes or vaults working on the same job. This requirement, which OSHA took from existing § 1910.269(t)(3)(iv), has no counterpart in § 1926.956(b)(1).

[442] The attendant may remain within the manhole only for the short period necessary to assist the employee inside the manhole with a task that one employee cannot perform alone. For example, if a second employee is necessary to help lift a piece of equipment into place, the attendant may enter only for the period needed to accomplish this task. However, if significant portions of the job require the assistance of a second worker in the manhole, the attendant may not remain in the manhole for the necessary period, and a third employee would have to provide the requisite assistance.

To install cables into the underground ducts, or conduits, that will contain them, employees use a series of short jointed rods, or a long flexible rod, inserted into the ducts. The insertion of these rods into the ducts is known as "rodding." Employees use the rods to thread the cable-pulling rope through the conduit. After withdrawing the rods and inserting the cable-pulling ropes, employees then can pull the cables through the conduit by mechanical means.

Paragraph (e), which is being adopted without substantive change from the proposal, requires the employer to ensure that employees install the duct rods in the direction presenting the least hazard to employees. To make sure that a rod does not contact live parts at the far end of the duct line being rodded, which would be in a different manhole or vault, this paragraph also requires the employer to station an employee at the remote, or far, end of the rodding operation to ensure that employees maintain the required minimum approach distances. This provision, which OSHA took from existing § 1910.269(t)(4), has no counterpart in existing Subpart V.

To prevent accidents resulting from working on the wrong, and possibly energized, cable, paragraph (f), which is being adopted without substantive change from the proposal, requires the employer to identify the proper cable when multiple cables are present in a work area. The employer must make this identification by electrical means (for example, a meter), unless the proper cable is obvious because of distinctive appearance, location, or other readily apparent means of identification. The employer must protect cables other than the one being worked from damage. This paragraph, which OSHA took from existing § 1910.269(t)(5), is similar to existing § 1926.956(c)(4), (c)(5), and (c)(6); however, existing § 1926.956(c)(4) and (c)(5) apply only to excavations. Final paragraph (f) applies the requirements to all underground installations.

If employees will be moving any energized cables during underground operations, paragraph (g) requires the employer to ensure that employees inspect these cables for abnormalities that could lead to a fault, except as provided in paragraph (h)(2). If the employees find an abnormality, final paragraph (h)(1) applies. These provisions protect employees against possibly defective cables, which could fault when moved, leading to serious injury. OSHA replaced "defects" in proposed paragraph (g) with "abnormalities" in the final rule for consistency with the language used in final paragraph (h). In addition, OSHA added language exempting employers from the inspection requirement when final paragraph (h)(2) permits employees to perform work that could cause a fault in an energized cable in a manhole or vault. Under paragraph (h)(2), employers may perform work that could cause a fault in a cable 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, and perform that work without the inspection required by paragraph (g), 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. Paragraph (g) in the final rule, which OSHA took from existing § 1910.269(t)(6), has no counterpart in existing Subpart V.

Since an energized cable with an abnormality may fail with an enormous release of energy, employers must take precautions to minimize the possibility of such an occurrence while an employee is working in a manhole or vault. Therefore, final paragraph (h) addresses conditions that could lead to a failure of a cable and injure an employee working in a manhole or vault.

Final paragraph (h)(1) provides that, if a cable in a manhole or vault has one or more abnormalities that could lead to a fault or be an indication of an impending fault, the employer must deenergize the cable before an employee may work in the manhole or vault, except when service-load conditions and a lack of feasible alternatives [443] require that the cable remain energized. For example, under some service-load conditions, it may not be feasible for the electric utility to deenergize the cable with the abnormality because the utility deenergized another line for maintenance work. In such cases, employees may enter the manhole or vault only if protected from the possible effects of a failure by shields or other devices capable of containing the adverse effects of a fault. Final paragraph (h)(1) provides that the employer must treat the following abnormalities as indications of impending faults: 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. However, if the employer can demonstrate that the listed conditions could not lead to a fault, final paragraph (h)(1) does not require the employer to take protective measures. This provision, which OSHA took from existing § 1910.269(t)(7), has no counterpart in existing Subpart V. OSHA revised the language in the final rule to clarify that it applies to abnormalities that "could lead to *a fault* or be an indication of an impending fault" (emphasis added). The Agency also included the information in the note to proposed paragraph (h)(1) in the regulatory text of this final paragraph to clarify that, when any of the abnormalities specifically listed in paragraph (h)(1) are present, the burden is on the employer to demonstrate that the abnormality could not lead to a fault.

As noted earlier in the discussion of the definition for "entry" under the summary and explanation for final § 1926.953(g), ConEd and EEI expressed concern that proposed § 1910.269(t)(7)(i) (and by implication its counterpart in proposed § 1926.965(h)(1)) would preclude the ability of an employer to enter a manhole or vault and hang a tag to indicate the presence of a defective cable.

Final § 1910.269(t)(7)(i) and its counterpart in final § 1926.965(h)(1) are substantially the same as existing § 1910.269(t)(7). These provisions generally prohibit employees from entering a manhole or vault containing a cable that has one or more abnormalities that could lead to a fault, or be an indication of an impending fault. Employers are unlikely to know about the abnormalities addressed by these provisions before employees enter the manholes or vaults in which they are present. The rule does not prohibit an initial entry into a manhole or vault, so long as the employer does not have actual or constructive knowledge of the abnormalities before the initial entry. If an employer uses the described tagging system to identify cables with these abnormalities, OSHA expects that the tags will be hung during the initial entry into the manhole or vault when employees first identify the abnormalities. Once the employer acquires knowledge of cables with abnormalities that could lead to a fault, or be an indication of an impending fault, the final rule prohibits additional entries unless the employer takes the precautions required by final paragraph (h)(1).

Paragraph (h)(2), which is being adopted without substantive change from the proposal, addresses work that could cause a fault in a cable, such as removing asbestos covering on a cable

[443] Feasible alternatives could include the use of shunts or other means of supplying areas with power.

or using a power tool to break concrete encasing a cable. This type of work can damage the cable and create an internal fault. The energy released by the fault could injure not only the employee performing the work, but any other employees nearby. Final paragraph (h)(2) requires the same protective measures in those situations as paragraph (h)(1), that is, deenergizing the cable or, under certain conditions, using shields or other protective devices capable of containing the effects of a fault.

Two commenters requested that OSHA clarify the meaning of the phrase "shields or other devices that are capable of containing the adverse effects of a fault" in proposed paragraph (h) (Exs. 0209, 0227). Both paragraphs (h)(1) and (h)(2) use this phrase. OSHA notes that the preamble to the proposal described the types of devices that employers could use to satisfy these requirements:

> For example, a ballistic blanket wrapped around a defective splice can protect against injury from the effects of a fault in the splice. The energy that could be released in case of a fault is known, and the energy absorbing capability of a shield or other device can be obtained from the manufacturer or can be calculated. As long as the energy absorbing capability of the shield or other device exceeds the available fault energy, employees will be protected. The proposal would require employees to be protected, regardless of the type of device used and of how it is applied. [70 FR 34884–34885]

This clarification applies equally to the final rule.

Mr. Lee Marchessault with Workplace Safety Solutions suggested that paragraph (h) also require consideration of FR clothing as outlined in proposed Appendix F (Ex. 0196).

Employers may use arc-rated clothing, which employers must use under final § 1926.960(g)(5), in combination with the shields or other devices specified by final paragraph (h), to achieve the protection from heat energy required by both of these provisions. However, paragraph (h) of the final rule requires a broader form of protection, including protection from flying objects and other hazards from the fault. Therefore, OSHA does not recognize FR or arc-rated clothing as a device that is capable, by itself, of containing the adverse effects of a fault as required by that paragraph.

Consolidated Edison objected to the wording of proposed paragraph (h)(2) and the explanation of proposed paragraph (h)(2) in the preamble to the proposal (70 FR 34885), commenting:

> While Consolidated Edison does not object to the concept that OSHA is trying to convey in this new provision, we find the wording to be unnecessarily vague. In the preamble to the proposed rule, OSHA uses the example of removing asbestos covering from a cable as a type of work that could cause a fault. In a given year, Con Edison conducts almost one hundred (100) projects in which we remove twenty-five (25) linear feet of asbestos covering from energized cable. This is the regulatory limit at which we must file for the project; it does not include projects where we remove less than the regulatory filing limit. Con Edison has a set procedure by which this work is conducted. This does not represent work that could be expected to cause a fault in a cable since we routinely conduct this work without cable faulting. In addition, we routinely remove arc-proof tape of non-asbestos type from cables that are energized without incident.
>
> In another example, you indicate that using a power tool to break concrete encasing a cable could cause a fault. Con Edison uses power tools to break concrete duct encasing energized cable as part of our normal operations. We took the time to analyze the operation and develop a procedure by which this can be done safely. By following this procedure, we successfully remove concrete (and other material) duct from energized cable.
>
> There are recognized work practices that could be expected to cause a fault in a cable but the two examples OSHA provides in the preamble to the proposed rule are not these type of operation. As currently written, the rule could preclude a great deal of work in a subsurface structure with energized cable even though there is no danger to employee safety. Therefore, we are suggesting that OSHA change the proposed language to the following:
>
> If the work being performed in a manhole or vault could *be expected to* cause a fault in a cable, that cable shall be deenergized 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 they are protected from the possible effects of a failure by shields or other devices that are capable of containing the adverse effects of a fault. [Ex. 0157; emphasis included in original]

EEI similarly objected to the language in proposed paragraph (h), arguing that "the wording as . . . proposed would eliminate any work in a structure with live equipment" (Ex. 0227). EEI recommended the following language to address its concerns: [444]

> If the work being performed in a manhole or vault *could be expected to lead to a fault in a cable,* that cable shall be deenergized before an employee may work on that cable. [*Id.;* emphasis included in original]

First, OSHA disagrees with Consolidated Edison with regard to the two examples of work that could cause a fault in a cable. In both cases, the cable is hidden from view—in one case, by an asbestos covering, and in the other case, by concrete. Employees cannot inspect the condition of the cable jacket and insulation, which may be decades old, until after removing the covering.[445] It is reasonable to expect that vibrations from the removal of an asbestos or concrete covering would move the encased cables, and any movement of a cable with an abnormality, even movement from vibrations, can lead to the failure of the cable (that is, a fault). In addition, there is at least one accident in the record involving the use of tools to remove concrete from underground cables, and others involving tools penetrating concrete-encased underground cables (Ex. 0004 [446]). Consequently, OSHA continues to believe that these are two good examples of work that could cause a fault in a cable.

Second, the Agency does not agree with EEI that the final rule will "eliminate any work in a structure with live equipment" (Ex. 0227). Final paragraph (h) requires employers to deenergize cables only under limited conditions. Paragraph (h)(1) requires the employer to deenergize a cable only when the cable has one or more abnormalities that could lead to a fault or be an indication of an impending fault. Paragraph (h)(2) requires the employer to deenergize a cable only when employees will perform work that could cause a fault in that cable. The final rule permits employees to work in manholes and vaults containing live equipment whenever the conditions specified in paragraphs (h)(1) and (h)(2) are not present, as well as when service-load conditions and a lack of feasible alternatives require that the cable remain energized.

Finally, OSHA is not adopting Consolidated Edison's (or EEI's) suggested language. The Agency does not believe that the recommended change would clarify the rule and

[444] Paraphrasing language from proposed paragraph (h)(1), EEI indicated that it was commenting on that provision of the proposal (Ex. 0227). However, EEI recommended revised language that would replace proposed paragraph (h)(2). In this discussion, OSHA responds to EEI's comment as it applies to proposed paragraph (h) generally and to the recommended language as a suggested replacement for proposed paragraph (h)(2).

[445] As noted earlier, final paragraph (g) requires employees to inspect energized cables before moving them, except as provided in paragraph (h)(2). OSHA added the exception, which the proposal did not make explicit, to clarify that paragraph (g) does not require an inspection when paragraph (h)(2) permits employees to perform work that could cause a fault in an energized cable in a manhole or vault.

[446] See, for example, the three accidents described at *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=170063499&id=144855585&id=170191100.*

believes that adopting the change would make the provision more difficult to enforce. Final paragraph (h)(2) does not require deenergizing cables when there is only a remote possibility that a fault would occur. There must be a reasonable possibility that performing the work could cause a fault. Such work would include: work in which employees are using tools or equipment in a manner in which they could foreseeably penetrate the cable jacket; work that would disturb a cable that employees cannot visually inspect; and any other work that could damage a cable. These are the types of activities that caused accidents in the record (Exs. 0002, 0003[447]). In addition, EEI's recommendation would only protect employees working on a cable. EEI's proposed language would not ensure the safety of employees performing work in the vicinity of, but not on, the energized cable in which a fault could occur. Such work would include work in which employees are using tools or equipment in a manner in which they could foreseeably penetrate the cable jacket, as noted previously. Therefore, OSHA concludes that EEI's language would not provide adequate protection to employees.

Paragraph (i), which is being adopted without substantive change from the proposal, requires employers to maintain metallic-sheath continuity while employees are working on buried cables or cables in manholes and vaults. Bonding across an opening in a cable's sheath protects employees against electric shock from a difference in electric potential between the two sides of the opening. As an alternative to bonding, the cable sheath can be treated as energized. (In this case, the voltage at which the sheath is to be considered energized is equal to the maximum voltage that could be seen across the sheath under fault conditions.) This requirement, which OSHA took from existing § 1910.269(t)(8), is essentially identical to existing § 1926.956(c)(7), except that the final rule allows the cable sheath to be treated as energized in lieu of bonding. This requirement is consistent with other parts of the final rule, such as § 1926.960(j), which recognize treating objects as energized as an alternative to grounding.

Mr. John Vocke with Pacific Gas and Electric Company objected to proposed paragraph (i) as follows:

> Paragraph (i) of proposed § 1926.965 would require metallic sheath continuity to be maintained while work is performed on underground cables. In its underground transmission system, PG&E has deliberately engineered certain circuits with discontinuous shield wires for system reliability. PG&E submits that as long as specific safety procedures are in place, underground transmission cables need not be equipped with metallic sheath continuity. [Ex. 0185]

Paragraph (i) of the final rule requires employers to maintain metallic-sheath continuity. It does not require these sheaths to be continuous across the system, nor does it require the employer to bond across breaks already installed in the system. As noted in the earlier explanation of this provision, it requires employers to place bonds when employees interrupt the continuity of the sheath as part of the work procedure (for example, when the employee strips the jacket, sheath, and insulation from a cable to splice it). Thus, Mr. Vocke's concern is unfounded. OSHA notes, however, that final § 1926.962(c) requires temporary protective grounds to be installed to prevent each employee from being exposed to hazardous differences in electric potential. Installing grounds in accordance with this provision will protect employees from hazardous differences in potential where designed breaks in metallic sheath continuity exist.

Mr. Brian Erga with ESCI recommended that OSHA add specific procedures for grounding underground cables (Exs. 0155, 0471; Tr. 1256–1257). He explained:

> IEEE has recognized the problem after a number of accidents involving de-energized cables. The industry has also recognized the hazard and has conducted research justifying the need for new safe work methods.
>
> Again, there ha[ve] been a number of serious accidents and fatalities when de-energized cable, thought to be . . . safely grounded, has been energized due to voltage rise on the system neutral. After an accident at San Diego Gas and Electric (SDG&E) involving a grounded cable [that] became energized, SDG&E conducted research in system neutral voltage rise. A paper was written and published on the research . . . . Also, the IEEE/ESMOL Task Force 15.07.09.01 published a paper titled "Worker Protection While Working De-energized Underground Distribution Systems". . . . [Ex. 0471]

Mr. Erga suggested provisions that included requiring the employer to (1) insulate employees from system neutral voltage rise, (2) isolate the cable and its associated neutral from system neutral voltage rise, or (3) create an equipotential zone at the work location (*id.*).

The final rule already addresses the provisions recommended by Mr. Erga. Final § 1926.962 requires employers to install grounds and provide an equipotential zone on lines treated as deenergized. Alternatively, the employer can treat the lines as energized. Paragraph (b) of final § 1926.962 also permits lines and equipment to be treated as deenergized without grounds under certain conditions; however, Mr. Erga did not include all of these conditions in his recommendations. Finally, final § 1926.962(g) prohibits grounding at a remote terminal if there is a possibility of hazardous transfer of potential should a fault occur. Thus, OSHA believes that the final rule adequately addresses the hazards covered by Mr. Erga's suggested regulatory text and decided not to adopt it. The Agency is, however, incorporating appropriate information from Mr. Erga's submission in Appendix C to final Subpart V, Protection from Hazardous Differences in Electric Potentials, to assist employers in complying with the requirements on grounding as they apply to underground installations.

17. Section 1926.966, Substations

As explained in paragraph (a), final § 1926.966 addresses work performed in substations. The provisions of this paragraph supplement (rather than modify) the general requirements contained in other portions of Subpart V, such as final § 1926.960, which regulates working on or near live parts.

Final paragraph (b) requires the employer to provide and maintain sufficient access and working space around electric equipment to permit ready and safe operation and maintenance of the equipment by employees. This rule prevents employees from contacting exposed live parts as a result of insufficient maneuvering room. A note following this paragraph recognizes, for compliance purposes, the provisions of ANSI/IEEE C2–2012, which address the design of workspace for electric equipment. Final § 1926.966(b), which OSHA took from existing § 1910.269(u)(1), has no counterpart in existing Subpart V.

OSHA realizes that older installations may not meet the dimensions set forth in the latest version of the national consensus standard. The Agency believes that the language of final paragraph (b) is sufficiently performance-oriented that older installations, likely built to specifications in the national consensus standards that were in effect during construction of the installation, will meet the requirement for sufficient workspace provided that the installation

[447] See, for example, the five accidents at *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=170065650&id=0144855856&id=170191100&id=170153977&id=170247944.*

and work practices used enable employees to perform work safely within the space and to maintain the minimum approach distances established by the employer under § 1926.960(c)(1)(i). The note to final § 1926.966(b) states that the NESC specifications are guidelines. That note indicates that OSHA will determine whether an installation that does not conform to that consensus standard complies with final paragraph (b) based on the following criteria:

(1) Whether the installation conforms to the edition of ANSI/IEEE 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.

The language in this note is equivalent to a note in existing § 1910.269(u)(1) and accomplishes three goals. First, it explains that an installation need not be in conformance with ANSI/IEEE C2–2012 to be in compliance with final paragraph (b). Second, it informs employers with installations that do not conform to the latest ANSI standard of how they can comply with final paragraph (b). Third, it ensures that, however old an installation is, it provides sufficient space to enable employees to work within the space without significant risk of injury. OSHA received no comments on either proposed paragraph (b) or the note and is adopting them without substantive change from the proposal. OSHA updated the version of ANSI/IEEE C2 listed in the note to the most recent edition (2012). OSHA reviewed ANSI/IEEE C2–2012 and finds that it provides protection equivalent to the 2002 edition referenced in the note in the proposal.

Paragraph (c), which is being adopted without substantive change from the proposal, requires the employer to ensure that, when employees remove or insert draw-out-type circuit breakers,[448] the breaker is in the open position. Additionally, if the design of the control devices permits, the employer must render the control circuit for the circuit breaker inoperable. These provisions prevent arcing that could injure employees. Final paragraph (c), which OSHA took from existing § 1910.269(u)(2), has no counterpart in existing Subpart V.

Because voltages can be impressed or induced on large metal objects near substation equipment, proposed paragraph (d) would have required conductive fences around substations to be grounded. In addition, the proposal specified that employers maintain grounding continuity and provide bonding to prevent electrical discontinuity when the employer expanded substation fences or removed sections of such fences.

OSHA took the proposed provision from existing § 1910.269(u)(3). Existing § 1926.957(g)(1) requires employers to maintain "[a]dequate interconnection with ground" between temporary and permanent fences, but does not require permanent substation fences to be grounded. In the preamble to the proposal, OSHA indicated that it believes that grounding metal fences, whether they are temporary or permanent, is essential to the safety of employees working near the fences (70 FR 34885).

OSHA received many comments on proposed paragraph (d). (See, for example, Exs. 0125, 0126, 0151, 0159, 0172, 0188, 0212.) Most of these commenters pointed out that the proposal was at odds with the methods of protecting employees and the general public from hazardous differences in electric potential described in IEEE Std 80–2000, *IEEE Guide for Safety in AC Substation Grounding.* (See, for example, Exs. 0125, 0126, 0151, 0159, 0172, 0188.) For instance, Mr. Jules Weaver with the Northwest Line Constructors Chapter of NECA commented:

> As currently written, [paragraph (d)] creates a situation in which *death or serious injury to both employees and the public exists.* When a substation fence is expanded or a section removed for working in an existing substation, the temporary fence installed to keep the work area secured shall not be bonded or the fence continuity maintained between the existing grounded fence enclosure and the temporary fence, as explained in IEEE Standard 80–2000 *"IEEE Guide for Safety in AC Substation Grounding" section 17.3.* When expanding a substation the practice is to remove the existing section of fence between the energized portion of the substation and the new section. The new section is fenced to protect the worksite and the public from unauthorized access into the energized sub. Temporary isolation fences are installed between the existing substation fence and the temporary fence to prevent touch and step potential hazards. *As stated in the current regulations by maintaining a bond and electrical continuity employees are exposed to these differences of potential.* As the new substation addition is built the following basic sequence of events occur, excavation of the existing soil is completed, foundations and footings are poured for equipment placement, control wiring and ground grid installed, and then final installation of rock placed creating the required insulation for employee protection. It is not until the new ground grid in the substation addition is installed and equipment in place does the connection between the new addition and the existing substation [begin]. As the new addition nears completion the fence isolation fences are removed, permanent fencing is installed, and the grid connected. It is at this critical time that the employees can be exposed to critical potential differences and proper work rules on bonding and grounding would be required. [Ex. 0188; emphasis included in original]

He recommended that OSHA modify paragraph (d) to read:

> Conductive fences around substations shall be grounded. When a substation fence is expanded or a section is removed, *they shall be designed to limit touch, step, and transferred voltages in accordance with industry practices.*
>
> **Note to paragraph . . . (d) . . . of this section:** *Guidelines for substation grounding as defined in IEEE Guide for Safety in AC substation Grounding (Standard 80–2000) would he one source that may be utilized to provide guidance in meeting these requirements.* [*Id.;* emphasis included in original]

OSHA agrees that this approach, which other commenters also recommended, would better protect employees than the proposed requirement. As demonstrated by the description quoted from Mr. Weaver's comment, employers isolate temporary fences from existing fences, in addition to bonding and grounding substation fence sections, to protect employees from hazardous differences in potential. The Agency also agrees that IEEE Std 80 provides useful guidance to protect employees from hazardous differences in electric potential. Therefore, OSHA adopted the following language in final paragraph (d):

> 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) of this section:** IEEE Std 80–2000, *IEEE Guide for Safety in AC Substation Grounding,* contains guidelines for protection against hazardous differences in electric potential.

[448] A draw-out-type circuit breaker is one in which the removable portion may be withdrawn from the stationary portion without unbolting connections or mounting supports.

The Agency believes that the language in the final rule addresses the commenters' concerns, as well as the concern of another commenter, who questioned whether isolation joints would be acceptable under the standard as proposed (Ex. 0212).

Final paragraph (e) addresses the guarding of rooms and other spaces that contain electric supply equipment. OSHA took this paragraph from existing § 1910.269(u)(4). Paragraphs (c) and (g) of § 1926.957 are the only provisions in existing Subpart V that address the guarding of live parts in substations. These two provisions require employers to install barricades or barriers (paragraph (c)) and to install temporary fences if sections of permanent fencing are expanded or removed (paragraph (g)). Existing § 1926.957(g)(2) also generally requires employers to lock gates to unattended substations.

The existing requirements only address temporary guarding measures. Existing § 1926.957 does not mention permanent guarding of live parts, which generally is more substantial than the tape and cone barricades permitted under the existing rule. OSHA's revision of the substation rules addresses guarding of live parts in substations in a more comprehensive manner and will provide better protection for employees than existing § 1926.957.

OSHA believes that it is important to prohibit unqualified persons from entering areas containing energized electric supply equipment, regardless of the work they are performing. Employees working in these areas must be trained in the hazards involved and in the appropriate work practices, as required by final § 1926.950(b)(2). This training will enable employees to distinguish hazardous circuit parts from nonhazardous equipment and will ensure that they are familiar with the appropriate work practices, regardless of the jobs they are performing. Many accidents occur because unqualified persons contact energized parts in such areas (Ex. 0004 [449]).

Subpart V applies to electrical installations for which OSHA has few design requirements. The Subpart K electrical installation standards typically do not apply to electric power transmission and distribution installations, and such installations may pose hazards in addition to the hazards associated with exposed live parts. For example, ungrounded equipment enclosures pose such hazards. If employers do not meet the requirements of Subpart K, then it is important to prevent unqualified persons from gaining access to areas containing electric power transmission and distribution equipment.

Paragraph (e) of final § 1926.966 sets forth criteria for access by unqualified persons to rooms and other spaces containing electric supply lines or equipment. Final paragraph (e)(1) specifies which areas containing electric supply lines or equipment must meet the guarding requirements contained in final paragraphs (e)(2) through (e)(5). These areas fall into three categories as follows:

(1) Rooms and other spaces where 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,

(2) Rooms and other spaces where live parts operating at 151 to 600 volts to ground are within 2.4 meters (8 feet) of the ground or other working surface and are guarded only by location, as permitted under final § 1926.966(f)(1), and

(3) Rooms and other spaces where live parts operating at more than 600 volts to ground are located, unless:

(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

(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.

Final paragraphs (e)(2) through (e)(5) contain requirements that apply to these areas. Fences, screens, partitions, or walls must enclose these rooms and other spaces so as to minimize the possibility that unqualified persons will enter; the employer must display signs at the entrances warning unqualified persons to keep out; and the employer must keep the entrances locked unless the entrances are under the observation of a person attending the room or other space for the purpose of preventing unqualified employees from entering. Additionally, unqualified persons may not enter these rooms or other spaces while the electric supply lines or equipment are energized.

OSHA received no comments on proposed paragraph (e) and is adopting it substantially as proposed. In the final rule, OSHA added metric equivalents that were missing from proposed paragraphs (e)(1)(i) and (e)(1)(ii). In addition, the Agency reworded paragraph (e)(5) in the final rule as follows: "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." Proposed paragraph (e)(5) would have required the employer to lock entrances to rooms and other spaces not under the observation of an "attendant." OSHA defined the word "attendant" in final § 1926.968 as "[a]n employee assigned to remain immediately outside the entrance to an enclosed or other space to render assistance as needed to employees inside the space." This term applies to provisions that require an attendant whose purpose is to protect employees within an enclosed or other space. In contrast, the purpose of the person attending the room or other space under final paragraph (e)(5) is to keep unqualified employees from entering the room or other space. Therefore, the use of the term "attendant" in proposed paragraph (e)(5) was inappropriate, and the revised language is more accurate.

Paragraph (f) also addresses guarding of live parts. This paragraph, which OSHA took from existing § 1910.269(u)(5), has no counterpart in existing Subpart V.

Paragraph (f)(1), which is being adopted without substantive change from the proposal, requires the employer to 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 to minimize the possibility of accidental employee contact. This provision protects qualified employees from accidentally contacting energized parts. Guidance for clearance distances appropriate for guarding by location is available in ANSI/IEEE C2. A note following final paragraph (f)(1) provides that OSHA considers installations meeting ANSI/IEEE C2–2002 to meet paragraph (f)(1), which OSHA based on Rule 124A1 of that standard.[450] The note further provides that OSHA will determine whether an installation that does not conform to this ANSI standard complies with paragraph (f)(1) 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

[449] See, for example, the eight accidents at *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=800995&id=170571012&id=902650&id=170571632&id=14529085&id=170681456&id=170681456&id=170108310.*

[450] The 2012 NESC contains a similar requirement in Rule 124A1.

(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.

This approach affords employers flexibility in complying with the standard and affords employees protection from injury due to sparkover from live circuit parts.

In developing the final rule, OSHA examined the 2012 version of ANSI/IEEE C2 to determine if the guarding requirements of the newer consensus standard protect employees to the extent required by final paragraph (f)(1) and ANSI/IEEE C2–2002. Rule 124A1 of ANSI/IEEE C2–2012 requires guarding of "live parts operating above 300 V phase-to-phase" rather than "live parts operating at more than 150 volts to ground" as required by final paragraph (f)(1). Therefore, some live parts that require guarding under the OSHA standard and ANSI/IEEE C2–2002 do not require guarding under ANSI/IEEE C2–2012. For example, an ungrounded, single-phase circuit operating at 240 volts between conductors has a phase-to-ground voltage of 240 volts.[451] The phase-to-phase voltage of this circuit also is 240 volts. Consequently, final paragraph (f)(1) and ANSI/IEEE C2–2002 require guarding of live parts on this circuit, while ANSI/IEEE C2–2012 does not. Accordingly, the Agency finds that ANSI/IEEE C2–2012 requires guarding of fewer live parts and, therefore, provides less employee protection than the OSHA standard and ANSI/IEEE C2–2002. The note to final paragraph (f)(1) retains the reference to ANSI/IEEE C2–2002, as proposed, rather than updating the reference to ANSI/IEEE C2–2012. However, with regard to the dimensions of clearance distances about electric equipment, employers can rely on ANSI/IEEE C2–2012 for providing sufficient clearance to minimize the possibility of accidental employee contact.

Paragraph (f)(2), which is being adopted without substantive change from the proposal, requires that the employer maintain guarding of energized parts within a compartment during operation and maintenance functions. This guarding will prevent accidental contact with energized parts and prevent tools or other equipment from contacting energized parts if an employee drops the tools or equipment. However, since qualified employees need access to energized equipment, an exception to this requirement allows qualified employees to remove guards to replace fuses and to perform other necessary work. In such cases, paragraph (f)(3), which also is being adopted without substantive change from the proposal, applies. When anyone removes guards from energized equipment, final paragraph (f)(3) requires the employer to 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.

Paragraph (g)(1), which is being adopted without substantive change from the proposal, requires employees who do not work regularly at the station to report their presence to the employee in charge of substation activities so that they can receive information on special system conditions affecting employee safety. Final paragraph (g)(2) requires the job briefing under final § 1926.952 to 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. OSHA took paragraphs (g)(1) and (g)(2) from existing § 1910.269(u)(6). The Agency revised the language in paragraph (g)(2) in the final rule to make it clear that the information covered in the job briefing must include all information on special system conditions affecting employee safety in the substation. Note that, unlike paragraph (g)(1), paragraph (g)(2) applies equally to unattended and attended substations, and to employees already working in a substation and employees who enter a substation.

Existing § 1926.957(a)(1) requires the employer to ensure that employees obtain authorization from the person in charge of the substation before performing work. Proposed paragraph (g) would not have required authorization. In the preamble to the proposal, OSHA stated that the Agency did not believe that such a requirement was necessary (70 FR 34886). Proposed paragraph (g)(1) would have required employees who do not work regularly in the substation to report their presence to the employee in charge. OSHA explained in the preamble to the proposal that the main purpose of this rule is to ensure a flow of important safety-related information from the employee in charge to employees about to work in the substation (70 FR 34887). The Agency believed that, as long as the employee in charge imparted this information to the employees performing the work and as long as employers followed the requirements proposed in the revision of Subpart V, employees could perform the work safely. Although OSHA did not believe that it was necessary to require that the employee in charge authorize the work, the Agency requested comments on whether the lack of authorization to perform work could lead to accidents.

Four commenters argued that the final rule should require authorization (Exs. 0167, 0209, 0219, 0227). Three of these commenters stated that lack of authorization can lead to accidents, but did not describe how or why such accidents could occur (Exs. 0209, 0219, 0227). The other commenter maintained that the only way to assure that employees receive the proper information is by requiring authorization by the employee in charge (Ex. 0167).

Other commenters supported the proposal and agreed with OSHA's preliminary conclusion that authorization is unnecessary. (See, for example, Exs. 0186, 0201, 0212, 0213.) Mr. Anthony Ahern with the Ohio Rural Electric Cooperatives succinctly described this reasoning as follows:

> [A]n employee is required to report to the person in charge. The person in charge knows who is present and what they are doing. Newly arrived employee[s] cannot start work until they receive their safety briefing. If the person in charge doesn't want the employee to start work on their particular task they will stop them at that time. Otherwise the employee will start working on their task after the safety briefing. [Ex. 0186]

The Agency agrees with Mr. Ahern that the act of reporting will give the employee in charge an opportunity to deny access if necessary. Therefore, the Agency is not including Subpart V's existing requirement for authorization in the final rule.

One commenter questioned: "Should there be a provision that states an unqualified person may enter a substation with a qualified employee, and must not touch anything, even if they are just doing a visual inspection?" (Ex. 0126).

OSHA notes that final § 1926.966(e) generally prohibits unqualified employees from entering rooms and other spaces containing unguarded energized supply lines or equipment. If it is necessary for such employees to enter these rooms and other spaces, employers must train them as qualified employees. Note that OSHA considers employees in training to be qualified employees under certain conditions, one of which is when they are under the direct supervision of a qualified employee. (For more detail, see CPL 02–01–038.)

[451] The 2002 and 2007 editions of ANSI/IEEE C2 define the phase-to-ground voltage on an ungrounded circuit as "[t]he highest nominal voltage available between any two conductors of the circuit concerned" (Ex. 0077).

Another commenter asked OSHA to clarify how proposed paragraph (g)(1) would apply to vendors and engineers who may be present, but do not directly work in substations (Ex. 0162).

Final paragraph (g)(1) does not require employees who are not performing work covered by Subpart V to report their presence to the employee in charge. In such cases, Subpart V would not be applicable.

Existing § 1926.957(a)(2) is essentially identical to final § 1926.966(g)(2), except that the existing rule, in paragraph (a)(2)(ii), also requires the determination of what protective equipment and precautions are necessary. Since final § 1926.952(b) already requires the job briefing to cover these areas, existing § 1926.957(a)(2)(ii), which applies only to work in energized substations, is no longer necessary. The Agency received no objection to this proposed change.

18. Section 1926.967, Special Conditions

Final § 1926.967 sets requirements for special conditions encountered during electric power transmission and distribution work. Except as noted otherwise, OSHA received no comments on this section.

Since capacitors store electric charge and can release electrical energy even when disconnected from their sources of supply, some precautions may be necessary—in addition to the precautions contained in final § 1926.961 (deenergizing lines and equipment) and final § 1926.962 (grounding)—when employees perform work on capacitors or on lines connected to capacitors. Paragraph (a), which is being adopted without substantive change from the proposal, contains precautions that will enable this equipment to be treated as deenergized. This paragraph, which OSHA took from existing § 1910.269(w)(1), has no counterpart in existing Subpart V. A note to paragraph (a) serves as a reminder that final §§ 1926.961 and 1926.962 apply to deenergizing and grounding capacitor installations.

Under final paragraph (a)(1), before employees work on capacitors, the employer must disconnect the capacitors from energized sources and short circuit the capacitors. In addition, the employer must ensure that the employee short circuiting the capacitors waits at least 5 minutes from the time of disconnection before applying the short circuit. This provision not only removes the sources of electric current, but also relieves the capacitors of their charge. Note that ANSI/IEEE Std 18–2012, *IEEE Standard for Shunt Power Capacitors,* requires all capacitors to have an internal discharge device to reduce the voltage to 50 volts or less within 5 minutes after the capacitor is disconnected from an energized source.[452]

Before employees handle the units, the employer must short circuit each unit in series-parallel capacitor banks between all terminals and the capacitor case or its rack; and, if the cases of capacitors are on ungrounded substation racks, the employer must bond the racks to ground. Final paragraph (a)(2) requires these measures to ensure that individual capacitors do not retain a charge. Final paragraph (a)(3) requires the employer to short circuit any line connected to capacitors before the line is treated as deenergized.

Although the magnetic flux density in the core of a current transformer usually is low, resulting in a low secondary voltage, it will rise to saturation if the secondary circuit opens while the transformer primary is energized. When the secondary opens, the magnetic flux will induce a voltage in the secondary winding high enough to be hazardous to the insulation in the secondary circuit and to workers. Because of this hazard to workers, paragraph (b), which is being adopted without substantive change from the proposal, prohibits the opening of the secondary circuit of a current transformer while the transformer is energized. If the employer cannot deenergize the primary of the current transformer before employees perform work on an instrument, a relay, or other section of a current transformer secondary circuit, the employer must bridge the circuit so that the current transformer secondary does not experience an open-circuit condition. This provision, which OSHA took from existing § 1910.269(w)(2), has no counterpart in existing Subpart V.

In a series streetlighting circuit, the lamps are connected in series, and the same current flows in each lamp. A constant-current transformer, which provides a constant current at a variable voltage from a source of constant voltage and variable current, supplies the current in a series streetlighting circuit. As with the current transformer, the constant current source attempts to supply current even to an open secondary circuit. The resultant open-circuit voltage can be extremely high and hazardous to employees. For this reason, final paragraph (c)(2) contains a requirement similar to that in paragraph (b). Under final paragraph (c)(2), before any employee opens a series loop, the employer must deenergize the streetlighting transformer and isolate it from the source of supply or must bridge the loop to avoid an open-circuit condition. In addition, final paragraph (c)(1) requires the employer to ensure that employees work on series streetlighting circuits with an open-circuit voltage of more than 600 volts in accordance with the requirements for overhead lines in final § 1926.964 or for underground electrical installations in final § 1926.965, as appropriate. Final paragraph (c), which OSHA took from existing § 1910.269(w)(3), has no counterpart in existing Subpart V, and the Agency is adopting it without substantive change from the proposal.

Frequently, electric power transmission and distribution employees must work at night, or in enclosed places, such as manholes, without natural illumination. Since inadvertent contact with live parts can be fatal, proper lighting is important to the safety of these workers. Therefore, paragraph (d), which is being adopted without substantive change from the proposal, requires the employer to provide sufficient illumination to enable the employee to perform the work safely. This provision, which OSHA took from existing § 1910.269(w)(4), is comparable to existing § 1926.950(f). The existing requirement in § 1926.950(f), however, applies only at night. OSHA believes that it is important for employees to have sufficient lighting to perform the work safely regardless of the time of day. The note following paragraph (d) refers to § 1926.56 for specific levels of illumination required under various conditions.

Paragraph (e) of the final rule sets requirements to protect employees working in areas that expose them to drowning hazards. Paragraph (e)(1), which is being adopted without substantive change from the proposal, requires the provision and use of personal flotation devices meeting § 1926.106 whenever an employee may be pulled or pushed, or might fall, into water where there is a danger of drowning.[453] Paragraph (e)(2), which is being adopted without substantive change from the proposal, requires that the employer maintain each personal flotation device in safe condition and

[452] The time limit is 5 minutes for capacitors rated over 600 volts and 1 minute for capacitors rated 600 volts or less.

[453] Paragraph (w)(5)(i) of § 1910.269 explicitly requires that the employer provide flotation devices approved by the U.S. Coast Guard, rather than referring to § 1926.106, which is a construction standard. Section 1926.106 also requires that the employer provide flotation devices approved by the U.S. Coast Guard.

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. Lastly, paragraph (e)(3) requires a safe means of passage, such as a bridge, for employees crossing streams or other bodies of water. This provision, which OSHA took from existing § 1910.269(w)(5), replaces existing § 1926.950(g). The existing rule at § 1926.950(g) simply references other construction standards on body belts, safety straps, and lanyards, on safety nets, and on protection for working over or near water, namely §§ 1926.104, 1926.105, and 1926.106. In final § 1926.967(e)(3), OSHA is adopting language nearly identical to that contained in existing § 1910.269 to ensure a safe means of passage, which the existing Subpart V rule does not address. In addition, existing § 1926.950(g) is unnecessary because the referenced construction standards apply.

Ms. Salud Layton with the Virginia, Maryland & Delaware Association of Electric Cooperatives objected to proposed paragraph (e)(3) because she believed it to be too broad (Ex. 0175). She stated that the U.S. Geological Survey designates "many intermitted streams on their topographic map that may not have running waters many times during the year" (*id.*). She also argued that the U.S. Army Corps of Engineers prohibits building bridges in certain wetlands. Ms. Layton maintained that workers wearing waders can cross safely some small streams.

OSHA notes that final paragraph (e)(3) does not require a bridge, but only a safe means of passage. A bridge is only one form of safe passage that employers can use to meet this requirement. A safe means of passage would exist when the water is shallow enough that workers wearing waders can cross it safely. Therefore, OSHA is adopting paragraph (e)(3) without substantive change from the proposal.

Paragraph (f) references Subpart P of Part 1926 for requirements on excavations. This provision is equivalent to existing § 1926.956(c)(2), which references §§ 1926.651 and 1926.652 of that subpart. The final rule clearly indicates that all of the requirements of Subpart P apply. OSHA is adopting paragraph (f) without change from the proposal.

Working in areas with pedestrian or vehicular traffic exposes employees to additional hazards compared to employees working on an employer's premises, where the employer generally restricts public access. One serious additional hazard faced by employees working in public areas is traffic mishaps (for example, impact with a vehicle or a pedestrian). Final paragraph (g) sets requirements to protect employees against injuries resulting from traffic mishaps. If employees work in the vicinity of vehicular or pedestrian traffic that may endanger them, paragraph (g)(2), which is being adopted without substantive change from the proposal, requires the employer to place warning signs or flags and other traffic-control devices in conspicuous locations to alert and channel approaching traffic. If the measures required by paragraph (g)(2) do not provide sufficient employee protection or if employees are working in an area in which there are excavations, paragraphs (g)(3) and (g)(4), which are being adopted without substantive change from the proposal, require the employer to erect barricades. Paragraph (g)(5), which is being adopted without substantive change from the proposal, requires the employer to display warning lights prominently for night work. Paragraph (g)(1) requires traffic-control signs and devices to meet § 1926.200(g)(2), which covers traffic-control devices. This provision in OSHA's construction standards requires compliance with Part VI of the Manual of Uniform Traffic Control Devices, 1988 Edition, Revision 3, September 3, 1993, FHWA–SA–94–027, or Part VI of the Manual on Uniform Traffic Control Devices, Millennium Edition, December 2000, Federal Highway Administration. OSHA is adopting paragraph (g)(1) without substantive change from the proposal. Paragraph (g), which OSHA took from existing § 1910.269(w)(6), has no counterpart in existing Subpart V.

Paragraph (h), which is being adopted without substantive change from the proposal, addresses the hazards of voltage backfeed due to sources of cogeneration or from the secondary system. Under conditions of voltage backfeed, the lines on which employees will perform work remain energized after the employer disconnects the main source of power. According to this provision, if there is a possibility of voltage backfeed from sources of cogeneration or from the secondary system, employers must have employees work the lines as energized under final § 1926.960 or work the lines deenergized following final §§ 1926.961 and 1926.962. The referenced requirements contain the appropriate controls and work practices employers must implement in case of voltage backfeed. Final paragraph (h), which OSHA took from existing § 1910.269(w)(7), has no counterpart in existing Subpart V.

Sometimes, electric power transmission and distribution work involves the use of lasers. Existing § 1926.54 of the construction standards contains appropriate requirements for the installation, operation, and adjustment of lasers. Paragraph (i), which is being adopted without substantive change from the proposal, requires the employer to install, adjust, and operate laser equipment in accordance with § 1926.54. Paragraph (i), which OSHA took from existing § 1910.269(w)(8), has no counterpart in existing Subpart V.

To ensure that hydraulic equipment retains its insulating value, paragraph (j) requires the hydraulic fluid used in insulated sections of hydraulic equipment to provide insulation for the voltage involved. Proposed paragraph (j) also contained an exemption from the requirement in § 1926.302(d)(1) that hydraulic fluid used in hydraulic-powered tools be fire-resistant. OSHA did not adopt the proposed exemption in final § 1926.967(j) because final § 1926.956(d)(1) already contains the relevant exemption.

Final paragraph (k) addresses communication facilities associated with electric power transmission and distribution systems. Typical communications installations include installations for microwave signaling and power line carriers. This paragraph, which OSHA took from existing § 1910.269(s), has no counterpart in existing Subpart V.

Paragraph (k)(1) addresses microwave signaling systems. To protect employees' eyes from injury caused by microwave radiation, paragraph (k)(1)(i), which is being adopted without substantive change from the proposal, requires employers to ensure that employees do not look into an open waveguide or antenna connected to an energized source of microwave radiation.

Existing § 1910.97, which covers nonionizing radiation, prescribes a warning sign with a special symbol to indicate nonionizing radiation hazards. Paragraph (k)(1)(ii), which is being adopted without substantive change from the proposal, provides that, if the electromagnetic-radiation level in an accessible area exceeds the radiation-protection guide set forth in § 1910.97(a)(2), the employer post the area with warning signs containing the warning symbol described in § 1910.97(a)(3). This paragraph also requires the lower half of that symbol to include the following statements or

statements 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.

The sign will warn employees about the hazards present in the area and inform them that special instructions are necessary to enter the area.

In § 1910.97, the radiation-protection guide is advisory only. In final paragraph (k)(1)(iii), OSHA makes the guide mandatory for electric power transmission and distribution work by requiring the employer to institute measures that prevent any employee's exposure from being greater than the exposure set forth in the guide. These measures may be administrative measures (such as limitations on the duration of exposure) or engineering measures (such as a design of the system that limits the emitted radiation to that permitted by the guide), or the measures may involve the use of personal protective equipment. This provision does not require employers to follow the hierarchy of controls normally required for the protection of employees from occupational hazards. Employees exposed to radiation levels beyond that permitted by the radiation-protection guide are typically performing maintenance tasks, and OSHA typically permits the use of personal protective equipment in lieu of engineering or administrative controls during work operations, such as some maintenance and repair activities, for which engineering and work-practice controls are not feasible. (See, for example, §§ 1910.1001(g)(1)(ii) (asbestos), 1910.1018(h)(1)(ii) (inorganic arsenic), and 1910.1028(g)(1)(ii) (benzene).) The Agency indicated in the preamble to the proposal that it did not believe any employees had radiation exposures exceeding the radiation-protection guide on a routine basis (70 FR 34888). The Agency requested comments on whether the proposal adequately protected employees and whether the standard should require employers to follow the hierarchy of controls.

No commenters suggested that OSHA apply the hierarchy of controls to electromagnetic-radiation exposure. However, Mr. Anthony Ahern with Ohio Rural Electric Cooperatives commented that "[e]xposure to really high power microwave radiation is diminishing as more and more of the big telcos are dismantling their microwave facilities in favor of fiber optic networks" (Ex. 0186). The record, therefore, does not contradict OSHA's determination that it is unnecessary in final paragraph (k)(1)(iii) to require that employers comply with the hierarchy of controls.

Two commenters maintained that § 1910.97 is out of date and recommended other, more protective guidelines (Exs. 0163, 0212). Ms. Susan O'Connor with Siemens Power Generation commented that ANSI, the American Conference of Governmental Industrial Hygienists, and the International Commission on Non-Ionizing Radiation Protection have guidelines that are more current and more protective than the requirements in § 1910.97 (Ex. 0163). She recommended that OSHA update § 1910.97 if the Agency references § 1910.97 in the final rule. Mr. Tom Chappell with Southern Company stated that the Federal Communications Commission's (FCC) OET Bulletin 65, Edition 97–01, *Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields,* has a two-tiered approach for setting permissible exposure limits for nonionizing radiation that "appears to provide a greater level of protection for employees" (Ex. 0212). He recommended that OSHA defer to the FCC in establishing employee exposure limits.

The purpose of this rulemaking is to set safety standards for employees working on electric power generation, transmission, and distribution installations and to set safety standards for electrical protective equipment. It is not the purpose of this rulemaking to set permissible exposure limits for nonionizing radiation. Therefore, the radiation-protection guide contained in § 1910.97 is outside the scope of this rulemaking, and OSHA is not revising § 1910.97 in this final rule.

The FCC authorizes and licenses devices, transmitters, and facilities that generate radio-frequency radiation. It has jurisdiction over all transmitting services in the United States, except services operated by the Federal government. (See *http://www.fcc.gov/oet/rfsafety/rf-faqs.html#Q10.*) However, the FCC's primary jurisdiction does not include the health and safety of employees, and the FCC relies on other agencies and organizations for guidance in such matters (*id.*). Therefore, OSHA decided that it would be inappropriate to defer establishing employee exposure limits to the FCC as recommended by Mr. Chappell. For these reasons, OSHA is adopting paragraph (k)(1)(iii) as proposed.

Power-line carrier systems use power lines to carry signals between equipment at different points on lines. Therefore, paragraph (k)(2), which is being adopted without substantive change from the proposal, requires the employer to ensure that employees perform work associated with power-line carrier installations, including work on equipment used for coupling carrier current to power line conductors, according to the requirements for work on energized lines. As a correction, the final rule replaces the term "this section," which was in the proposal, with "this subpart."

Comments Regarding Heightened Sensitivity to Electromagnetic Radiation

Some rulemaking participants recommended that OSHA adopt protection for workers who are sensitive to electromagnetic radiation. (See, for example, Exs. 0106, 0482; Tr. 326–352.) These commenters maintained that some individuals are especially sensitive to electromagnetic radiation from sources such as computers, power lines, and other electric equipment (*id.*) For example, Ms. M. Matich Hughes commented that sensitive individuals react to this type of radiation with a wide range of symptoms, including itching, redness, swelling, and stinging (Ex. 0106). Some of these commenters also pointed to papers supporting their claims (Exs. 0106, 0482). For instance, Drs. Diane and Bert Schou, and Mr. Paul Schou, submitted several papers, and referenced others, on the effects of electromagnetic radiation in humans and animals (Ex. 0482).

OSHA declines to regulate exposure to electromagnetic radiation in this rulemaking for several reasons. First, the relevant portion of this rulemaking focuses on the safety hazards associated with the maintenance and construction of electric power generation, transmission, and distribution installations.[454] The hazards that these commenters address appear to be health hazards posed by electromagnetic radiation. The commenters maintain that only certain individuals are sensitive to electromagnetic radiation (see, for example, Ex. 0106 ("a California Department of Health Services survey has found that 3 percent of the people interviewed reported that they are unusually sensitive to electric appliances or power lines"), Ex. 0124 ("It is most easily understood as a radiation type injury that affects . . . a population estimated at 3 to 5 percent in the world"), and Tr. 330 ("we're talking about three percent worldwide of the people who are very, very

[454] This rulemaking also addresses electrical protective equipment, a subject unrelated to electromagnetic radiation.

sensitive")) and that symptoms may develop or worsen after long-term exposure (see, for example, Ex. 0482 ("High [electromagnetic radiation] exposure for a short time is preferred to long time low power [electromagnetic radiation]"). Second, these commenters are requesting that OSHA address hazardous conditions that go far beyond the work covered by the final rule. The commenters maintain that there are many sources of electromagnetic radiation that can cause symptoms. (See, for example, Ex. 0106 ("[Electromagnetic radiation] sensitivity is . . . associated with exposure to electromagnetic fields created by computers, power lines and other electronic equipment") and Tr. 334 ("Sources that [can trigger electromagnetic radiation sensitivity] include the fluorescent lights[,] remote meters[,] broadband on power lines, [and] wireless Internet").) Thus, to the extent that electromagnetic radiation poses "sensitivity hazards," those hazards are not unique to work on electric power generation, transmission, and distribution installations, but are present in nearly all workplaces. OSHA, therefore, concludes that this rulemaking is not a proper vehicle for regulating the hazards identified by these commenters.

19. Section 1926.968, Definitions

Final § 1926.968 contains definitions of terms used in Subpart V. Since OSHA based these definitions, in large part, on consensus standards and existing OSHA rules, and since the definitions included are generally self-explanatory, OSHA believes the regulated community understands these terms well; therefore, with a few exceptions, this discussion of final § 1926.968 provides no explanation of the terms' definitions. For terms having meanings that may not be readily apparent, the Agency is providing an explanation of the definition of each of these terms in the discussion of the provision in which the term first appears. The following table shows where in this preamble OSHA discusses some of the key definitions.

Term	See the summary and explanation for:
Contract employer	§ 1926.950(c), Information transfer.
Enclosed space	§ 1926.953(a), Enclosed spaces, General.
Entry	§ 1926.953(g), Hazardous atmosphere.
Exposed	§ 1926.960(b)(3), At least two employees. § 1926.960(g)(1), Hazard assessment.
Fall restraint system	§ 1926.954(b)(3)(iii), Care and use of personal fall protection equipment.
Host employer	§ 1926.950(c), Information transfer.
Isolated	§ 1926.960(b)(3), At least two employees.
Line-clearance tree trimming	§ 1926.950(a)(3), Applicable Part 1910 requirements.
Personal fall arrest system	§ 1926.954(b)(3)(iii), Care and use of personal fall protection equipment.
Work-positioning equipment	§ 1926.954(b)(3)(iii), Care and use of personal fall protection equipment.

OSHA based the definition of "qualified employee" on the definition of that term as set forth in existing § 1910.269(x). This definition states that a qualified employee is an employee knowledgeable in the construction and operation of the electric power generation, transmission, and distribution equipment involved, along with the associated hazards.

As OSHA indicated in the preamble to the proposal, the Agency is not requiring that a "qualified employee" be knowledgeable in all aspects of electric power generation, transmission, and distribution equipment (70 FR 34888—34889). OSHA believes that this definition will convey the true meaning of this term. Note that the final rule uses the term "qualified employee" to refer only to employees who have the training to work on energized electric power transmission and distribution installations. Paragraph (b)(2) of final § 1926.950 sets out the training an employee must have to be a qualified employee. OSHA included a note to this effect following the definition of the term. OSHA received no comments on the definition of "qualified employee" and is adopting it without substantive change from the proposal.

One commenter requested that the standard define "fire-resistant clothing" (Ex. 0237). This commenter noted that untreated cotton, regardless of weight, is not considered "fire-resistant" and asked that the final rule clarify this point.

As the commenter pointed out in its submission, a footnote in proposed Appendix F described flame-resistant clothing as follows:

> Flame-resistant clothing includes clothing that is inherently flame resistant and clothing that has been chemically treated with a flame retardant. (See ASTM F1506–02a, Standard Performance Specification for Textile Materials for Wearing Apparel for Use by Electrical Workers Exposed to Momentary Electric Arc and Related Thermal Hazards.) [70 FR 34977]

OSHA decided not to include a definition of "flame-resistant clothing" in the final rule. From the comments received on the record, the Agency believes that affected employers and employees understand that untreated cotton is not flame-resistant for the purposes of final § 1926.960(g)(4). Because final § 1926.960(g)(5) requires arc-rated protection, and because most FR clothing has an arc rating, OSHA also believes that employers generally will use arc-rated clothing to meet both requirements. (See, for example, Tr. 545.) In any event, the Agency included a separate topic in Appendix E explaining what OSHA means by FR and arc-rated clothing, so that employers will know what clothing to purchase.

IBEW objected to the definition of "system operator" as it applied to the control room operator in a generating station (Exs. 0230, 0480; Tr. 905). The union maintained that generating plants do not have system operators, stating:

> Most generating stations have a control room operator that is responsible for all operations related to a specific generating unit. System operators are usually located in some type of system operations center and are responsible for operations of the transmission system. There is available technology for computer systems operated by system operators to have some form of automated generation control . . . in a specific transmission system, but the operations of the generating unit, specifically the installation of lockout/tagout devices are the responsibility of station personnel, probably the control room operator. OSHA should make the appropriate changes. [Ex. 0230]

IBEW recommended that OSHA adopt a different term, "control room operator,"

summary and explanation for § 1926.960(g), earlier in this section of the preamble. That preamble discussion also responds to some of the comments OSHA received on proposed Appendix F. Several other comments addressed the appendix; OSHA discusses these comments here.

Proposed Appendix F included tables for estimating incident-energy levels based on voltage, fault current, and clearing times (proposed Table 8 and Table 9, which OSHA adopted as Table 6 and Table 7 in Appendix E of the final rule). Employers could use these tables to estimate incident energy for exposures involving phase-to-ground arcs in open air. The proposed appendix also included a table giving protective clothing guidelines for electric-arc hazards (Table 10, which OSHA did not adopt in the final rule). This table described protective clothing that employers could use for different ranges of estimated incident energy.

Noting that the energy is *inversely proportional* to the distance, NIOSH pointed out that proposed Appendix F incorrectly stated that the amount of heat energy is *directly proportional* to the distance between the employee and the arc (Ex. 0130). OSHA corrected the appendix accordingly.

Three commenters made recommendations for clarifying the information presented in proposed Appendix F. First, NIOSH recommended:

- Revising the headings in Table 8 and Table 9 (Table 6 and Table 7 in Appendix E of the final rule) to reflect more clearly that the values in the table represent maximum clearing times at specified maximum incident-energy levels,
- Making it clear that unqualified references to "cotton" in the appendix meant "untreated cotton,"
- Describing how to use the arc rating on the clothing label to select clothing appropriate for a given estimate of incident energy,
- Clarifying that the standard prohibits the use of meltable undergarments, and
- Clarifying that employer-added logos on arc-rated clothing can adversely affect the arc rating and FR characteristics of the clothing (*id.*).

Second, TVA recommended that OSHA clarify that workers can sustain burns even when wearing appropriately selected protection because there is a 50-percent chance that a worker will sustain a second-degree burn at the arc rating of the protective equipment (Ex. 0213). Third, Mr. Paul Hamer recommended that the Agency note the method used to calculate the incident-energy values in proposed Table 8 and Table 9 (Table 6 and Table 7 in Appendix E of the final rule) (Ex. 0228).

OSHA believes that these recommendations will serve to provide additional useful guidance to workers and employers. Therefore, OSHA is adopting all of these suggestions in Appendix E of the final rule.

Mr. James Thomas, president of ASTM International, recommended adding ASTM F1891–02b, *Standard Specification for Arc and Flame Resistant Rainwear,* as a reference within proposed Appendix F (Ex. 0148).

OSHA agrees that ASTM F1891 contains recognized standards for particular types of arc-rated protective equipment. Therefore, OSHA added a reference to ASTM F1891–12, the latest edition of the consensus standard, in Appendix E in the final rule.

Leo Muckerheide with Safety Consulting Services requested that OSHA stress the limitations of the various methods of estimating incident heat energy, in particular the limitations included in the notes to proposed Table 8 and Table 9 (Table 6 and Table 7 in Appendix E of the final rule) (Ex. 0180). He expressed concern that employers would use the methods inappropriately and ignore notes and other information limiting their use.

As noted in the summary and explanation for final § 1926.960(g)(2), OSHA is including information on the acceptable use of the various calculation methods in Appendix E of the final rule. The Agency also made it clear in the captions to Table 6 and Table 7 in the final appendix that those tables only apply to exposures involving phase-to-ground arcs in open air.

Proposed Appendix F included the following statement, "Outer flame-resistant layers may not have openings that expose flammable inner layers that could be ignited." Mr. Anthony Ahern with Ohio Rural Electric Cooperatives objected to this statement because it would require buttoning the top button on a shirt worn over an untreated cotton T-shirt, which could increase discomfort and heat stress (Ex. 0186).

The Agency dismissed objections to FR and arc-rated clothing based on comfort and heat stress as noted under the summary and explanation for final § 1926.950(g)(5). In addition, the exposed portion of a T-shirt poses an ignition hazard. Existing § 1910.269(l)(6)(iii), which proscribes the wearing of clothing that could increase the extent of injury in the event of exposure to flames or electric arcs, already prohibits exposing flammable garments, including T-shirts, to possible ignition from an electric arc.[455] Therefore, OSHA did not adopt Mr. Ahern's recommendation to remove the quoted statement from the appendix.

Lee Marchessault with Workplace Safety Solutions recommended that OSHA replace references to ARCPRO in proposed Appendix F with references to "commercially available software" (Ex. 0196; Tr. 582). He noted that software other than that mentioned in the appendix was available, such as EasyPower (Tr. 582, 598).

Today, there is a much wider array of software available for calculating incident heat energy from an electric arc. However, the basis of most of this software, including EasyPower, is the NFPA 70E Annex D or IEEE 1584 methods. The Agency is not aware of any software that uses a calculation method, other than the heat flux calculator, that is not already listed in Table 2 of Appendix E in the final rule. As discussed earlier under the summary and explanation for final § 1926.960(g)(2), ARCPRO uses its own calculation method validated through testing of electric arcs. As explained in that same portion of the preamble, OSHA found the heat flux calculator to be an unacceptable method of estimating incident heat energy. The Agency believes that it is essential to inform employers of what methods OSHA will deem acceptable, and not all available software for calculating incident energy from an arc will provide reasonable estimates of incident heat energy. Consequently, Table 2 of Appendix E in the final rule lists ARCPRO as an acceptable method. However, the appendix notes that other software that yields results based on any of the listed methods is also acceptable. In addition, as noted earlier under the summary and explanation for final § 1926.960(g)(2), an employer is free to choose a method that is not listed in the appendix if the chosen method reasonably predicts the potential incident-heat-energy exposure of the employee.

Some rulemaking participants recommended that OSHA revise Table 8 and Table 9 in proposed Appendix F (Table 6 and Table 7 in Appendix E of the final rule) to reflect an incident-energy level of 4 cal/cm^2 rather 5 cal/cm^2 (Exs. 0228, 0230, 0383; Tr. 410–412, 490–491). Mr. Norfleet Smith with

[455] See, for example, the August 10, 1995, memorandum to regional administrators from James W. Stanley, "Guidelines for the Enforcement of the Apparel Standard, 29 CFR 1910.269(l)(6), of the Electric Power Generation, Transmission, and Distribution Standard" (*http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=21878*).

applicable to the lockout-tagout requirements in § 1910.269(d) and defined as follows:

Control room operator. A qualified employee who operates an electric generating system or its parts from within a centralized control room. [Ex. 0480]

In final § 1926.968, "system operator" means a "qualified person designated to operate the system or its parts." This is a generic definition that OSHA believes applies equally to the employees in the dispatch center operating a transmission or distribution system and to the employees in the control room of a power generating plant who control the generation system and apply lockout-tagout devices. OSHA recognizes that the utility industry views these two groups of employees as being distinct and may even frequently use the term "system operator" exclusively for the transmission and distribution operators (though some utilities call these employees "dispatchers" (Exs. 0167, 0508)). However, from the description of the energy control procedures in the 1994 § 1910.269 rulemaking record, and even from IBEW's own recommended definition, it is clear that the control room operator in a generation plant serves the same function as a system operator for a transmission or distribution system (269-Ex. 12–6; Ex. 0480). Therefore, the Agency concludes that a control room operator in a generation plant is "designated" by the employer to "operate" or control "the [generation] system or its parts" and, thus, meets the definition for "system operator" contained in the final rule. For these reasons, OSHA is adopting the definition of "system operator" as proposed.

20. Appendices

OSHA is including six appendices to final Subpart V. The first of these appendices is Appendix A. Proposed Appendix A to Subpart V referred to Appendix A to § 1910.269. The general industry appendix contains flow charts depicting the interface between § 1910.269 and the following standards: § 1910.146, Permit-required confined spaces; § 1910.147, The control of hazardous energy (lockout/tagout); and Part 1910, Subpart S, Electrical. Appendix A to § 1910.269 has little relevance, if any, to work covered by Subpart V, as that appendix only contains information relevant to the application of general industry standards. Therefore, the Agency is not adopting proposed Appendix A to Subpart V.

Lee Marchessault with Workplace Safety Solutions expressed concern that Appendix A to § 1910.269 granted electric power generation, transmission, and distribution work an exemption from Subpart S of the general industry standards (Ex. 0196; Tr. 582–583). Based on his experience as an electrician, he believed that there were some hazards covered by Subpart S that § 1910.269 does not address.

OSHA did not propose any changes to existing Appendix A to § 1910.269 and is adopting it in § 1910.269 of this final rule without substantive change. This appendix does not grant an exemption from Subpart S for electric power generation, transmission, and distribution work. It simply provides guidance, in the form of a flowchart, on how § 1910.269 and Subpart S apply to various installations. OSHA is not altering the scope of Subpart S in any way. In fact, final § 1910.269(a)(1)(ii)(B) explicitly states that § 1910.269 does not apply to "electrical installations, electrical safety-related work practices, or electrical maintenance considerations covered by Subpart S of this part." Therefore, Mr. Marchessault's concerns are groundless.

Appendix B provides information relating to the determination of appropriate minimum approach distances under final § 1926.960(c)(1)(i). In the proposed rule, OSHA based this appendix on existing Appendix B to § 1910.269, with revisions necessary to reflect the changes to the minimum approach distances proposed for § 1910.269 and Subpart V. In this final rule, OSHA revised this appendix as necessary to account for the calculation methods required by final § 1926.960(c)(1)(i) and Table V–2. OSHA based these revisions on: (1) the findings made with regard to minimum approach distances (see the summary and explanation for § 1926.960(c)(1), under the heading *Minimum approach distances,* earlier in this section of the preamble); (2) IEEE Std 516–2009 (Ex. 0532); and (3) draft 9 of IEEE Std 516 (Ex. 0524). The appendix includes a discussion, based on IEEE Std 516–2009 (Ex. 0532), regarding how to determine the maximum transient overvoltage for a system.

Proposed Appendix C provided information relating to the protection of employees from hazardous step and touch potentials as addressed in proposed §§ 1926.959(d)(3)(iii)(D), 1926.963(d)(3)(ii), and 1926.964(b)(2). As discussed under the summary and explanation for final § 1926.962(c), earlier in this section of the preamble, the Agency expanded this appendix to incorporate guidance on protecting employees from hazardous differences in potential as required by that provision in the final rule. OSHA renamed this appendix accordingly. OSHA based the additional material in this appendix on IEEE Std 1048–2003 (Ex. 0046). Appendix C in the final rule also includes examples of how to achieve equipotential grounding as required by final § 1926.962(c). The Agency based these examples on information in the IEEE standard and on the principle from the consensus standard that installing grounds of adequate ampacity (as required by § 1926.962(d)(1)) and sufficiently low impedance (as required by § 1926.962(d)(2)) and adequately bonding all conductive objects within the work zone will minimize potential differences (Ex. 0046). As discussed in the summary and explanation for § 1926.962(c), earlier in this preamble, OSHA will deem employers using the examples in Appendix C to be in compliance with that final paragraph. Employers are free to use other methods of grounding as long as they can demonstrate that those other methods will prevent exposure of each employee to hazardous differences in electric potential.

Appendix D contains information on the inspection and testing of wood poles addressed in final § 1926.964(a)(2). This appendix describes ways to test wood poles to ensure that they are sound. Proposed Appendix D described how to test a wood pole using a "hammer weighing about 1.4 kg (3 pounds)." Ms. Salud Layton with the Virginia, Maryland & Delaware Association of Electric Cooperatives recommended deleting the weight of the hammer from the appendix (Ex. 0175). She maintained that lighter hammers are as effective in sounding a pole as a 1.4-kilogram hammer.

OSHA notes that Appendix D is not mandatory. It contains guidelines that employers may choose to follow in inspecting and testing wood poles. Thus, employers may use lighter or heavier hammers if they find them to be effective. However, Appendix D provides some guidance on what weight hammer OSHA knows to be effective in testing wood poles. The Agency took the weight given in Appendix D directly from § 1910.268(n)(3)(i). Therefore, the Agency is not adopting Ms. Layton's recommendation and is adopting Appendix D substantially as proposed.

Appendix E, which OSHA proposed as Appendix F, provides guidance on the selection of protective clothing and other protective equipment for employees exposed to flames or electric arcs as addressed in final § 1926.960(g). The Agency modified this appendix to reflect the final rule as discussed in the

E. I. du Pont de Nemours and Company described the reasons for this change as follows:

[T]he 5 cal column in Tables 8 and 9 of Appendix F [should] be changed to be 4 cals, and the respective clearing times in those charts [should] be updated accordingly. That's what we propose. . . .

[T]here are numerous U.S. based electric utility companies that have adopted flame resistant protective clothing systems under 1910.269, and . . . many of those clothing systems today meet 4 calories per square centimeter arc thermal performance ratings but may not meet 5 cal per centimeter square arc thermal performance ratings.

These employers would be forced to modify their existing clothing programs, should the new rule go into effect as it is written today.

Further, NFPA 70E has already defined hazard risk categories of 4, 8, 25, and 40 cals per square centimeter, and flame resistant protective clothing systems have already been developed to match those levels. Having both a 4 calorie per square centimeter category in NFPA 70E and a 5 calorie per square centimeter category in OSHA 29 CFR 1910.269 and 1926.960 may create confusion and inefficiency in the garment supply system.

Since Tables 8 and 9 of Appendix F have maximum clearing times listed which are generated using commercially available software programs, the appropriate clearing times for 4 calories per square centimeter can be modified to support that rating, and no loss of protection would occur, as the new maximum clearing times would match the new protection levels of 4 calories per square centimeter. . . .

Lastly, as referenced on one of the pages in the proposed rule, . . . "clothing is currently widely available in ratings from about 4 calories per square centimeter to over 50 calories per square centimeter." [Tr. 410–412]

In addition, IBEW pointed out that the NESC subcommittee with responsibility for work rules adopted a proposal with charts equivalent to Table 8 and Table 9 in proposed Appendix F (Table 6 and Table 7 in Appendix E of the final rule), except that the minimum incident heat energy listed in the NESC proposal was 4 cal/cm² rather than 5 cal/cm² (Ex. 0230). The union submitted the NESC proposal to the Subpart V rulemaking record; the NESC proposal also contained corrections to some of the values reflected in the proposed OSHA tables (*id.*).[456]

OSHA agrees with these rulemaking participants that some employers already have programs using protective equipment with an arc rating of 4 cal/cm². Although the Agency does not agree that keeping a 5-cal/cm² minimum incident-energy level in final Table 6 and Table 7, which are not mandatory, would force employers to upgrade their existing protection to match the higher level, OSHA does believe that a 4-cal/cm² minimum energy level would facilitate compliance for many of these employers. Therefore, Table 6 and Table 7 in the final rule adopt the lower minimum incident-energy level. In addition, OSHA is correcting the clearing times in those tables.

Mr. Paul Hamer recommended that Table 8 and Table 9 in proposed Appendix F (Table 6 and Table 7 in Appendix E of the final rule) list clearing times for incident-energy levels corresponding to the NFPA 70E hazard-risk categories (4, 8, 25, and 40 cal/cm²) because, in his view, these are the levels that industry already is using (Ex. 0228).

Although industries other than the electric utility industry use the hazard-risk categories in NFPA 70E, evidence in the record indicates that electric utilities and their contractors for electric power transmission and distribution work do not widely use this consensus standard. (See, for example, Ex. 0212 ("[NFPA 70E] was developed primarily for premise[s] wiring, not utility type electric systems. The systems covered by the [hazard-risk category task table] are not utility type distribution or transmission systems. The tables are therefore not applicable for utility [transmission and distribution] systems.") OSHA believes that the NESC proposal better reflects incident-energy levels appropriate for the types of systems addressed by final Table 6 and Table 7, that is, overhead transmission and distribution lines.[457] Table 6 and Table 7 apply only to exposures involving phase-to-ground arcs in open air, which are the types of exposures found predominantly in work on overhead transmission and distribution lines. Consequently, OSHA is not adopting Mr. Hamer's recommendation.

Some commenters urged OSHA to replace Table 10 in proposed Appendix F with a similar table from NFPA 70E, Table 130.7(C)(11), protective clothing characteristics (Exs. 0190, 0228, 0235). Mr. Frank White with ORC Worldwide noted that OSHA appeared to have based Table 10 in the proposal on a 1996 IEEE paper that was significantly older than NFPA 70E–2004 (Ex. 0235). He asked OSHA to explain why it is not basing the table on the more recent consensus standard. Mr. Thomas Stephenson with International Paper commented, "Based on my research, of the readily available single layer shirts, the highest ATPV rating is 8.2 cal/sq cm. Based on Table 10, this shirt would not be acceptable for a 5.1 cal/sq cm exposure" (Ex. 0190). He noted that many companies base their electrical safety programs, including PPE, on NFPA 70E and recommended that the rule match that consensus standard.

OSHA did not include proposed Table 10 in the final rule. The Agency agrees with these commenters that Table 10 in proposed Appendix F is out of date. There also is evidence in the record indicating that arc-rated clothing is getting lighter and that even Table 130.7(C)(11) in NFPA 70E–2004 might be out of date (Tr. 493). Appendix E in the final rule explains that any protective clothing and other protective equipment that meets the employer's reasonable estimate of incident heat energy is acceptable. For example, employers may use protective shirts and pants rated at 12 cal/cm² for an estimated exposure of 12 cal/cm².

Some rulemaking participants pointed out an error in the way the proposed appendix described the energy level expected to produce a second-degree burn injury (Exs. 0213, 0228; Tr. 540). These commenters noted that the threshold of second-degree burn injury, as reflected in NFPA 70E and IEEE Std 1584, is 1.2 cal/cm², unless the fault-clearing time is under about 0.1 second. For the faster clearing times, the threshold is 1.5 cal/cm² (*id.*).

OSHA agrees with these comments and revised the language in Appendix E in the final rule to indicate that the threshold for second-degree burn injury is 1.2 to 1.5 cal/cm².

Appendix F in the final rule, which OSHA proposed as Appendix G, contains guidelines for the inspection of work-positioning equipment to assist employers in complying with final § 1926.954(b)(3)(i). OSHA received no comments on this appendix and is adopting the appendix substantially as proposed.

Appendix G in the final rule, which OSHA proposed as Appendix E, contains references to additional sources of information that supplement the requirements of Subpart V. The national consensus standards referenced in this appendix contain detailed specifications to which employers may refer in complying with the performance-oriented requirements of OSHA's final rule. Except as specifically noted in Subpart V, however, compliance with the national consensus standards is not a substitute for

[456] IEEE subsequently adopted the NESC proposal, which is contained in Table 410–1 and 410–2 of the 2007 NESC. The 2012 NESC contains equivalent tables in Table 410–2 and 410–3, though the values in Table 410–3 are different from the values in 2007 NESC Table 410–2.

[457] The corresponding tables in the 2007 and 2012 NESC provide clearing times for incident-energy levels of 4-, 8-, and 12 cal/cm².

compliance with the provisions of the OSHA standards.

OSHA listed the most recent versions of the consensus standards in final Appendix G. In some cases, the version of the consensus standard in the record is older than the version listed in the appendix. In other cases, the consensus standard is not contained in the record at all. However, OSHA based the requirements in the final rule only on the consensus documents and other data contained in the record. The Agency evaluated any editions of the consensus standards listed in the appendix that are not in the record for consistency with OSHA's final rule. The Agency determined that these later consensus standards conform to the requirements of final Subpart V, as specifically noted in the final rule, and that these later consensus standards provide information useful for employers and workers in complying with the final rule.

C. Part 1910 Revisions

1. Sections 1910.137 and 1910.269

The construction of electric power transmission and distribution lines and equipment nearly always exposes employees to the same hazards as the maintenance of electric power lines and equipment. Power line workers use the same protective equipment and safety techniques in both types of work. During the course of a workday, these employees can perform both types of work.

For example, an employer might assign a power line crew to replace one failed transformer with an equivalent one and a second failed transformer with a transformer with a different kilovolt-ampere rating. When the employees perform the first job, they are performing maintenance work covered by Part 1910. However, the second job would be construction and covered by Part 1926. The employees would almost certainly use identical work practices and protective equipment for both jobs.

Because of this, OSHA believes that, in most cases, it is important to have the same requirements apply regardless of the type of work performed. If the corresponding Part 1910 and Part 1926 standards are the same, employers can adopt one set of work rules covering both types of work. Employers and employees will generally not have to decide whether a particular job is construction or maintenance—a factor that, in virtually every instance, has no bearing on the safety of employees. (For a discussion of comments suggesting that OSHA combine Subpart V and § 1910.269 into one rule, refer to the introductory paragraphs in the summary and explanation of final § 1926.950.)

Therefore, OSHA is adopting revisions to §§ 1910.137 and 1910.269 so that the construction and maintenance standards will be substantially the same.[458] The following cross-reference table shows the major paragraphs in final § 1910.269 and the corresponding section in final Subpart V:[459]

Major paragraph in § 1910.269	Corresponding section in subpart V
(a) General	§ 1926.950 General.
(b) Medical services and first aid	§ 1926.951 Medical services and first aid.
(c) Job briefing	§ 1926.952 Job briefing.
(d) Hazardous energy control (lockout/tagout) procedures [applies only to work involving electric power generation installations].	§ 1926.950(a)(3)—Subpart V applies § 1910.269 to work involving electric power generation installations.
(e) Enclosed spaces	§ 1926.953 Enclosed spaces.
(f) Excavations	§ 1926.967(f) Excavations.
(g) Personal protective equipment	§ 1926.954 Personal protective equipment.
(h) Portable ladders and platforms	§ 1926.955 Portable ladders and platforms.
(i) Hand and portable power equipment	§ 1926.956 Hand and portable power equipment.
(j) Live-line tools	§ 1926.957 Live-line tools.
(k) Materials handling and storage	§ 1926.958 Materials handling and storage.
(l) Working on or near exposed energized parts	§ 1926.960 Working on or near exposed energized parts.
(m) Deenergizing lines and equipment for employee protection	§ 1926.961 Deenergizing lines and equipment for employee protection.
(n) Grounding for the protection of employees	§ 1926.962 Grounding for the protection of employees.
(o) Testing and test facilities	§ 1926.963 Testing and test facilities.
(p) Mechanical equipment	§ 1926.959 Mechanical equipment.
(q) Overhead lines and live-line barehand work	§ 1926.964 Overhead lines and live-line barehand work.
(r) Line-clearance tree-trimming operations	§ 1926.950(a)(3)—Subpart V applies § 1910.269 to line-clearance tree-trimming operations.
(s) Communication facilities	§ 1926.967(k) Communication facilities.
(t) Underground electrical installations	§ 1926.965 Underground electrical installations.
(u) Substations	§ 1926.966 Substations.
(v) Power generation	§ 1926.950(a)(3)—Subpart V applies § 1910.269 to work involving electric power generation installations.
(w) Special conditions	§ 1926.967 Special conditions.
(x) Definitions	§ 1926.968 Definitions.
Appendices A through G	Appendices A through G, respectively.

The following distribution table presents the major revisions and a brief summary of OSHA's rationale for adopting them. The full explanation of the changes and the rationale for adopting them is in the summary and explanation for the corresponding provision in final § 1926.97 or Subpart V.

[458] Subpart V does not contain requirements for work involving electric power generation installations or line-clearance tree-trimming operations. See the summary and explanation for final § 1926.950(a)(3), earlier in this section of the preamble.

[459] Existing § 1910.269 contains an introductory note explaining that OSHA is staying the enforcement of certain provisions of existing § 1910.269 until November 1, 1994, and of existing § 1910.269(v)(11)(xii) until February 1, 1996. OSHA is not including this note in final § 1910.269 because it is no longer applicable. OSHA is not including this note in final § 1910.269 because it is no longer applicable.

Existing part 1910 paragraph	New part 1910 paragraph	Part 1926 revision	Rationale and comments
§ 1910.137		§ 1926.97	
(b)	(c)	(c)	Existing § 1910.137(b) redesignated as § 1910.137(c) for consistency with § 1926.97.
(a)(1)(ii), (b)(2)(vii), and Table I–2, Table I–3, Table I–4, and Table I–5.	(a)(1)(ii), (c)(2)(vii), and Table I–1, Table I–2, Table I–3, and Table I–4.	(a)(1)(ii), (c)(2)(vii), and Table E–1, Table E–2, Table E–3, and Table E–4.	Section 1910.137 revised to include Class 00 rubber insulating gloves.
The note following (a)(3)(ii)(B)	The note following (a)(3)(ii)(B).	The note following (a)(3)(ii)(B).	Note revised to include the latest ASTM standards. References to ASTM definitions and to an ASTM guide for visual inspection of rubber insulating equipment included to provide additional useful information for complying with the OSHA standard.
A new note following (b)(2)(ii)	A new note following (c)(2)(ii)	The note following (c)(2)(ii) ...	A reference to an ASTM guide for visual inspection of rubber insulating equipment included to provide additional useful information for complying with the OSHA standard.
	(b) [New]	(b)	A new paragraph added to cover electrical protective equipment not made of rubber.
(b)(2)(vii)(B)	(c)(2)(vii)(C) and (c)(2)(vii)(D)	(c)(2)(vii)(C) and (c)(2)(vii)(D)	Existing § 1910.137(b)(2)(vii)(B) divided into two separate CFR units.
§ 1910.269		Subpart V	
(a)(2)(i)	(a)(2)(i)(A), (a)(2)(i)(B), and (a)(2)(i)(C).	§ 1926.950(b)(1)(i), (b)(1)(ii), and (b)(1)(iii).	Existing § 1910.269(a)(2)(i) divided into three separate CFR units. The last of those units, paragraph (a)(2)(i)(c), adopts a new requirement that employers determine the degree of training by the risk to the employee.
	(a)(2)(ii)(E) [New]	§ 1926.950(b)(2)(v)	A new paragraph added to require employers to train qualified employees to recognize electrical hazards and to control or avoid them.
(a)(2)(vii)	(a)(2)(viii)	§ 1926.950(b)(7)	The existing requirement for employers to certify that they trained employees has been replaced with a requirement for employers to determine that employees demonstrated proficiency in the work practices involved. In addition, a new note added to clarify how training received in a previous job would satisfy the training requirements.
	(a)(2)(iii) [New]	None	A new paragraph added to require training for line-clearance tree trimmers. (See the summary and explanation for § 1926.950(b)(2).)
	(a)(3) [New]	§ 1926.950(c)	A new paragraph added to require host employers and contract employers to share information on safety-related matters.
(a)(3)	(a)(4)	§ 1926.950(d)	Existing § 1910.269(a)(3) redesignated as § 1910.269(a)(4) for consistency with Subpart V.
(c)	(c)	§ 1926.952	The existing provisions on job briefing reorganized and renumbered. A new requirement added to ensure that employers provide the employee in charge with information that relates to the determination of existing characteristics and conditions.
The note following existing (e)(6).	None	None	This note removed. It currently references § 1910.146 for the definition of "entry." OSHA added a definition of this term to § 1910.269(x), so this note is unnecessary.
(e)(7)	(e)(7)	§ 1926.953(h)	OSHA removed the requirement to provide an attendant if there is reason to believe a hazard exists in the enclosed space. The introductory text to § 1910.269(e) requires the entry to conform to § 1910.146 if there are hazards for which the requirements of § 1910.269(e) and (t) do not provide adequate protection. Thus, if an employer has reason to believe that a hazard exists despite the precautions taken under § 1910.269(e) and (t), then § 1910.146 applies and requires an attendant.
(e)(8)	(e)(8)	§ 1926.953(i)	The existing requirement revised to clarify that the test instrument must have an accuracy of ±10 percent.

Existing part 1910 paragraph	New part 1910 paragraph	Part 1926 revision	Rationale and comments
(e)(12)	(e)(12)	§ 1926.953(m)	The existing requirement revised to require the employer to be able to demonstrate that it maintained ventilation long enough to ensure that a safe atmosphere exists before employees enter an enclosed space.
(g)(2)	(g)(2)	§ 1926.954(b)	The existing requirements revised to maintain consistency with the construction provisions.
(i)(2)(i)	None	None	The existing requirement was removed because it is unnecessary. See the summary and explanation for final § 1926.956(b).
(i)(2)(ii)(C)	(i)(2)(iii)	§ 1926.956(b)(3)	The final rule limits the voltage on isolating transformers used with cord- and plug-connected equipment to 50 volts.
(l)(1), introductory text	(l)(1)(i), (l)(1)(ii), and (l)(1)(iii)	§ 1926.960(b)(1)(i), (b)(1)(ii), and (b)(2).	The introductory text to existing § 1910.269(l)(1) divided into three separate CFR units.
(l)(1)(i) and (l)(1)(ii)	(l)(2)(i) and (l)(2)(ii)	§ 1926.960(b)(3)(i) and (b)(3)(ii).	Existing § 1910.269(l)(1)(i) and (l)(1)(ii) redesignated as § 1910.269(l)(2)(i) and (l)(2)(ii) for consistency with Subpart V.
(l)(2) and existing Table R–6 through Table R–10.	(l)(3) and Table R–3 through Table R–9.	§ 1926.960(c)(1) and Table V–2 through Table V–8.	The final rule revises, and requires the employer to establish, minimum approach distances that employees must maintain from exposed energized parts. Note that, in other provisions, the final rule replaces references to minimum approach-distance tables with references to the minimum approach-distance requirements in § 1910.269(l)(3)(i) or § 1926.960(c)(1)(i), as appropriate.
(l)(2)(i)	(l)(3)(iii)(A)	§ 1926.960 (c)(1)(iii)(A)	The existing requirement clarified to indicate that an energized part must be under the full control of the employee for rubber insulating gloves or rubber insulating gloves and sleeves to be sufficient insulation from that part.
(l)(3) and (l)(4)	(l)(4) and (l)(5)	§ 1926.960(c)(2) and (d)	OSHA revised the existing requirements to ensure that employees use electrical protective equipment whenever they can reach within the minimum approach distance of an energized part.
(l)(5)	(l)(6)	§ 1926.960(e)	Existing § 1910.269(l)(5) redesignated as § 1910.269(l)(6) for consistency with Subpart V.
(l)(6)	(l)(7) [Revised] and (l)(8) [New].	§ 1926.960(f) and (g)	OSHA revised the requirements on clothing in existing § 1910.269(l)(6)(ii) and (iii) to require the employer to protect employees from electric arcs. Existing paragraph (l)(6)(i) redesignated as new paragraph (l)(7), and the new protective clothing and other protective equipment requirements added as paragraph (l)(8).
(l)(7) through (l)(10)	(l)(9) through (l)(12)	§ 1926.960(h) through (k)	Existing § 1910.269(l)(7), (l)(8), (l)(9), and (l)(10) redesignated as new § 1910.269(l)(9), (l)(10), (l)(11), and (l)(12), respectively.
(m)(3)(viii)	(m)(2)(iv)(A) [New] and (m)(2)(iv)(B).	§ 1926.961(b)(4)	The existing provision revised to require independent crews to coordinate energizing and deenergizing lines and equipment. A new paragraph has been added requiring multiple crews to coordinate their activities under a single employee in charge and to act as a single crew.
(n)(6) and (n)(7)	(n)(6)(i) and (n)(6)(ii)	§ 1926.962(f)(1) and (f)(2)	The existing requirement revised to allow, under certain conditions, insulating equipment, other than a live-line tool, to place grounds on, or remove them from, circuits of 600 volts or less.
(p)(4)(i)	(p)(4)(i)	§ 1926.959(d)(1)	OSHA revised this provision to clarify that, if an insulated aerial lift comes closer to an energized part than the minimum approach distance, the aerial lift must maintain the minimum approach distance from objects at a different potential.
(t)(3), (t)(7), and (t)(8)	(t)(3), (t)(7), and (t)(8)	§ 1926.965(d), (h), and (i)	OSHA revised these requirements to apply to vaults as well as manholes. Additionally, OSHA added a requirement (paragraph (t)(7)(ii)) to address work that could cause a cable to fail.

Existing part 1910 paragraph	New part 1910 paragraph	Part 1926 revision	Rationale and comments
The notes following (u)(1) and (v)(3).	The notes following (u)(1) and (v)(3).	The note following § 1926.966(b).	OSHA updated the references in these notes from ANSI C2–1987 to ANSI/IEEE C2–2012.
The notes following (u)(5)(i) and (v)(5)(i).	The notes following (u)(5)(i) and (v)(5)(i).	The note following § 1926.966(f)(1).	OSHA updated the references in these notes from ANSI C2–1987 to ANSI/IEEE C2–2002.
(x)	(x)	§ 1926.968	OSHA added definitions of "contract employer," "first-aid training," "host employer," and "entry." (See the discussion of final §§ 1926.950(c), 1926.953(g), and 1926.953(h) in the preamble discussion of final Subpart V.)
Appendix E to § 1910.269	Appendix G to § 1910.269	Appendix G to Subpart V	OSHA redesignated this appendix as Appendix G to § 1910.269. In addition, the final rule updates the references contained in this appendix.
	Appendix E to § 1910.269 [New].	Appendix E to Subpart V	OSHA added a new appendix containing information on protecting employees from electric arcs.
	Appendix F to § 1910.269 [New].	Appendix F to Subpart V	OSHA added a new appendix containing guidelines for the inspection of work-positioning equipment.

OSHA received several comments on provisions in existing § 1910.269 that the Agency did not propose for revision.[460] Mr. Mark Spence with Dow Chemical Company maintained that, in the years since OSHA promulgated § 1910.269, "industrial establishments have had some difficulties in adapting to this utility-oriented rule" (Ex. 0128). He recommended that, in promulgating this final rule, OSHA "take the differences between industrial establishments and electric utilities into account and establish different provisions for each as appropriate" (*id.*). He provided two examples. For the first, he noted that electric utilities generally follow the NESC whereas industrial establishments generally follow the NEC and NFPA 70E. For the second example, he noted that electric utilities frequently use contractors to perform work "off-site," but that industrial establishments typically have contractors' employees working on-site, side-by-side with their own employees.

OSHA is not setting separate requirements for industrial establishments in final § 1910.269. First, OSHA rejected a similar comment during the 1994 rulemaking. One of the commenters in that rulemaking opposed the application of § 1910.269 to industrial establishments because "[t]raditionally, industrial electrical systems have been based upon the [NEC] in their design and operation" and "[u]tility electrical systems, on the other hand, have always been based upon the [NESC] in their design and operation" (269-Ex. 3–45). In rejecting this comment, OSHA reasoned in part that "there are hazards related to electrical power generation, transmission, and distribution work that are not adequately addressed elsewhere in the General Industry Standards" (59 FR 4334). Mr. Spence provides no basis to support a conclusion that OSHA's determination on this issue in the 1994 rulemaking was erroneous, and OSHA continues to find its earlier determination to be valid.

Second, OSHA believes that whether contractors work off-site or on-site is not relevant to the issue of whether § 1910.269 should apply to industrial establishments. The work practices required by the final rule are necessary for employee safety without regard to whether an industrial establishment's employees are working alone or alongside contractor employees.[461]

Third, the Agency believes that, at least for electric power generation facilities and plant distribution substations, there are more similarities between electric utilities and industrial establishments than portrayed by Mr. Spence. There is evidence that some electric utilities with electric power generation plants refer to NFPA 70E for electrical safety guidelines. (See, for example, Exs. 0214 and 0217, which both list NFPA 70E, but not the NESC, as references for TVA's electrical safety practices in electric power generation plants.) OSHA, therefore, finds that it is not necessary or appropriate to adopt Mr. Spence's recommendation for promulgating separate requirements for electric utilities and industrial establishments.

EEI petitioned OSHA to revise the group lockout-tagout and system-operator provisions in existing § 1910.269(d)(8)(ii) and (d)(8)(v) (Exs. 0227, 0501).

OSHA hereby denies EEI's petition. In doing so, OSHA reexamined the evidence supporting the promulgation of the existing group lockout-tagout provisions in 1994 and continues to find that evidence persuasive. OSHA also finds that the evidence on which EEI relies in support of its petition does not justify revising the standard, as explained in the following paragraphs.

OSHA designed the requirements for hazardous energy control (lockout-tagout) procedures in existing § 1910.269(d) to protect employees working on electric power generation installations from injury while maintaining or servicing machinery or equipment that is part of that installation. Paragraph (d) of existing § 1910.269, which is almost identical to OSHA's general industry standard for the control of hazardous energy at § 1910.147, requires the employer to "establish a program consisting of

[460] OSHA stated in the proposal that it was seeking comment on entire §§ 1910.137 and 1910.269 (70 FR 34892). However, OSHA also stated:

Comments received on the general industry standards will be considered in adopting the final construction standards and vice versa. In particular, the Agency has requested comments on several issues in the proposed revision of Subpart V and in proposed new § 1926.97. Some of these issues are directed towards requirements in those construction standard that are taken from general industry provisions that OSHA is not proposing to revise. For example, earlier in this section of the preamble, the Agency requests comments on whether AEDs should be required as part of the medical and first-aid requirements in proposed § 1926.951. (See the summary and explanation of proposed § 1926.951(b)(1).) Although OSHA has not proposed to revise the corresponding general industry provision, existing § 1910.269(b)(1), the Agency intends to revise that general industry provision if the rulemaking record supports a requirement for AEDs. Therefore, OSHA encourages all rulemaking participants to respond to these issues regardless of whether the participants are covered by the construction standards. [*Id.*]

[461] Comments, including comments from Mr. Spence, regarding the requirement proposed in §§ 1910.269(a)(4)(ii)(B) and 1926.950(c)(2)(ii) for contract employers to follow the host employer's safety-related work rules are discussed in the summary and explanation for final § 1926.950(c)(3).

energy control procedures, employee training, and periodic inspections to ensure that, before any employee performs any servicing or maintenance on a machine or equipment where the unexpected energizing, start up, or release of stored energy could occur and cause injury, the machine or equipment is isolated from the energy source and rendered inoperative" [462] (existing § 1910.269(d)(2)(i)). In part, existing § 1910.269(d) requires: the employer to isolate the machine or equipment from hazardous energy sources before servicing begins; authorized employees to affix lockout or tagout devices to the switches, disconnects, and other means used to isolate the machine or equipment after the employer isolates the machine or equipment but before servicing or maintenance begins; and authorized employees to remove their lockout or tagout devices before the machine or equipment is reenergized (existing § 1910.269(d)(6)(ii) and (d)(6)(iii), (d)(6)(iv), and (d)(7)). The standard generally prohibits anyone from removing a lockout or tagout device other than the employee who placed it (existing § 1910.269(d)(7)(iv)). This prohibition protects the employee who is performing work on the machine or equipment from injury resulting from the reenergization of hazardous energy by someone else.

The existing § 1910.269 group lockout-tagout provision, which is identical to the analogous general industry provision (§ 1910.147(f)(3)), makes it clear that each individual authorized employee must take an affirmative step to accept and release his or her own protection under the lockout-tagout standard and that this affirmative step must be traceable to the employee and under that employee's control. The group lockout-tagout provision applies "[w]hen servicing or maintenance is performed by a . . . group" of workers (existing § 1910.269(d)(8)(ii)). Although this provision allows certain variations from the individual servicing model, it requires a lockout-tagout "procedure which affords the employees a level of protection equivalent to that provided by the implementation of a personal lockout or tagout device." In particular, "[e]ach authorized employee shall affix a personal lockout or tagout device to the group lockout device, group lockbox, or comparable mechanism when he or she begins work and shall remove those devices when he or she stops working on the machine or equipment being serviced or maintained" (existing § 1910.269(d)(8)(ii)(D)).

The existing § 1910.269 system-operator provision in paragraph (d)(8)(v) is the only provision that has no analog in the general industry standard. In the 1994 § 1910.269 rulemaking, OSHA found that "the only concept employed by electric utilities that is unique to their industry is the use of central control facilities" (59 FR 4364). To account for this unique aspect of power generation plants, the standard provides that when "energy isolating devices are installed in a central location and are under the exclusive control of a system operator," so that the servicing employees cannot individually affix and remove their personal lockout or tagout devices, the system operator may "place and remove lockout and tagout devices in place of the" servicing employees (existing § 1910.269(d)(8)(v)). However, as with the existing group lockout-tagout provision, the existing system-operator provision requires the employer to "use a procedure that affords employees a level of protection equivalent to that provided by the implementation of a personal lockout or tagout device." In the preamble discussion, OSHA elaborated on this language, stating that, under the system operator provision, procedures must "ensure that no lock or tag protecting an employee is removed without the knowledge and participation of the employee it is protecting" (59 FR 4364). The preamble also stated that the procedures must ensure that no one operates locked-out or tagged-out energy-isolating devices without the employee's personal authorization (*id.*). As such, the requirement for personal control and accountability in the existing standard's group lockout-tagout and system-operator provisions is clear.

EEI's petition for rulemaking marks the latest stage in a long-running dispute between OSHA and EEI over appropriate lockout-tagout procedures in the electric power generation industry. Even before OSHA proposed the existing Power Generation Standard, and throughout that rulemaking, EEI urged OSHA to adopt a standard that would allow supervisors to maintain exclusive control of energy isolating devices in group-servicing operations (59 FR 4322, 4350–4351, 4360, 4363–4364). OSHA definitively rejected EEI's suggestions when it promulgated the standard in 1994. Since OSHA promulgated the existing standard, EEI sought repeatedly to have the standard's personal control and accountability provisions nullified.[463]

In its petition for rulemaking, EEI once again challenges the validity of the existing § 1910.269(d)(8)(ii) requirements for group lockout-tagout to provide "a level of protection equivalent to that provided by the implementation of a personal lockout or tagout device" and for each authorized employee to "affix a personal lockout or tagout device to the group lockout device, group lockbox, or comparable mechanism when he or she begins work and [to] remove those devices when he or she stops working on the machine or equipment being serviced or maintained" (the "personal control and accountability requirements"). OSHA addresses EEI's assertions, and the Agency's rationale for rejecting those assertions, in the following paragraphs.

1. EEI asserted that OSHA should revise the existing standard to permit electric utilities to use procedures that were in place before the promulgation of the 1994 standard; that is, OSHA should permit the person who is responsible for servicing the equipment (referred to by the electric utility industry as "the person who holds the clearance") to communicate orally with the employees working on the equipment instead of requiring measures equivalent to applying a personal lockout-tagout device.

OSHA decided not to adopt EEI's suggestion to remove the existing personal control and accountability requirements from the final standard. The Agency found in the 1994 rulemaking on § 1910.269 that application of personal lockout-tagout devices by each authorized employee in a group was necessary and reasonable, stating, "OSHA is convinced that the use of individual lockout or tagout devices as part of the group lockout provides the greatest assurance of protection for servicing employees" (59 FR 4361). There was clear evidence in the 1994 rulemaking that individual protection was necessary, including evidence that "work authorizations under [electric utility generation plant]

[462] Throughout the final rule, OSHA changed "inoperative" wherever it appeared in the existing standard to "inoperable." "Inoperable," which means "incapable of being operated," is the more precise of the two terms. ("Inoperative" means "not working.") Paragraph (c)(1) of § 1910.147, which is identical to existing § 1910.269(d)(2)(i), continues to use "inoperative." OSHA intends to publish a technical amendment making a similar change to § 1910.147(c)(1) in the near future.

[463] In its latest effort, EEI challenged the validity of the § 1910.269 compliance directive on the basis that the standard did not contain a requirement for personal control and accountability (*EEI v. OSHA*, 411 F.3d 272 (D.C. Cir. 2005)). The United States Court of Appeals for the District of Columbia Circuit rejected that challenge, and in doing so, noted that EEI "should have made [its] points in a challenge to the 1994 Standard-a challenge that it began but later withdrew—not in a petition to review a compliance directive issued nearly a decade later" (*id.* at 282).

tagging systems had been released under pressure from supervisory personnel or without the knowledge of the employee who held the authorization" (59 FR 4351).

EEI's suggested change would have the principle authorized employee, or, as the trade association put it, the "holder of the clearance," be responsible for the safety of all authorized employees working under the lockout-tagout for the group. Such a change would be inconsistent with the fundamental principle adopted in the general industry lockout-tagout rulemaking, and again in the 1994 § 1910.269 rulemaking, that each individual authorized employee controls his or her own lockout-tagout. As the Occupational Safety and Health Review Commission held in rejecting a challenge to the personal control and accountability requirements in existing § 1910.269, "the core concept of lockout/tagout is *personal* protection" (*Exelon Generating Corp.*, 21 BNA OSHC 1087, 1090 (No. 00–1198, 2005); emphasis included in original). Vesting power over and responsibility for an employee's protection from the release of hazardous energy in another employee allows for the types of abuse reported in the 1994 rulemaking record.

As the primary rationale for its suggested revisions, EEI attacked the validity of the existing rule resulting from the 1994 rulemaking record. EEI maintained that "[t]here was no evidence when Section 1910.269 was adopted . . . that electric utility workers were at significant risk of harm under the unique procedures that had been used successfully in the industry for decades" (Ex. 0227). Second, EEI contended that OSHA did not show that "sign-on, sign-off requirements in utility power plants were reasonably necessary to eliminate or reduce a significant [risk] of harm to affected employees" (*id.*). Third, EEI asserted that OSHA did not show that the cost of compliance bears any relationship to expected benefits or that OSHA considered "the cost of compliance with the sign-on, sign-off principle" (*id.*).

EEI bases these arguments on the false premise that OSHA must make hazard-by-hazard significant risk findings in vertical standards. As explained in detail in Section II.D, Significant Risk and Reduction in Risk, earlier in this preamble, there is no such legal requirement. During the 1994 rulemaking, OSHA examined the injuries and fatalities in the electric power generation, transmission, and distribution industry, and concluded that "hazards of work on electric power generation, transmission, and distribution installations pose a significant risk to employees and that the standard is reasonably necessary and appropriate to deal with that risk" (59 FR 4321). OSHA also found that the existing standard's lockout-tagout and other provisions would "significantly" reduce the number of injuries associated with "uncontrolled exposure to occupational hazards" and that the economic impacts on affected industry groups would be small (59 FR 4431–4434). Finally, OSHA examined nonregulatory alternatives and concluded that "the need for government regulation arises from the significant risk of job-related injury or death caused by inadequate safety practices for electric power generation, transmission, and distribution work" (59 FR 4432).

In any event, although OSHA does not agree that hazard-specific significant risk findings are necessary, the record in the 1994 rulemaking supports such a finding with respect to the standard's personal control and accountability requirements. EEI's first argument on this issue was that "[t]here was no evidence when Section 1910.269 was adopted . . . that electric utility workers were at significant risk of harm under the unique procedures that had been used successfully in the industry for decades" (Ex. 0227). According to EEI, OSHA applied the principles and assumptions about risk in general industry in adopting lockout-tagout requirements taken from the general industry lockout-tagout standard without accounting for the unique methods proven to be safe in the electric power generation plants of electric utilities (*id.*).

In the preamble to the 1994 final rule on § 1910.269, OSHA explicitly rejected EEI's argument that electric utility employees were not at significant risk of injury under then-existing lockout-tagout procedures:

> In both the Subpart S work practices rulemaking and the [general industry] hazardous energy control rulemaking, OSHA found existing electric utility lockout and tagging procedures to expose employees to a significant risk of injury (55 FR 32003, 54 FR 36651–36654, 36684). In a review of IBEW fatality reports, Eastern Research Group, Ind., found 4 of 159 fatalities (2.5%) could have been prevented by compliance with proposed § 1910.269(d) (Ex. 6–24). These fatalities occurred among approximately 50,000 electric utility employees at high risk (Ex. 4: Table 3–22 with the population limited to generating plant workers at high risk) at the rate of nearly 2 per year (2.5% of the estimated 70 deaths per year; Ex. 5). The Agency believes that these employees are exposed to a significant risk of injury under existing industry practices. Otherwise, no lockout and tagging standard would have been proposed. OSHA evaluates significant risk based on the hazards that exist under the current state of regulation. [59 FR 4363]

Second, during the rulemaking for the 1994 rule, OSHA also rejected EEI's claim about the successful use of then-existing procedures by the electric utility industry. For instance, the Agency found that "although some electric utility companies have had excellent success with their tagging systems, other companies have had problems" (59 FR 4351). The Agency also reported that "the electric utility industry had [at least] 14 fatalities and 17 injuries recorded in OSHA files that were directly caused by a failure of the lockout/tagout procedure in use, during the period of July 1, 1972, to June 30, 1988" (*id.*; internal citation omitted). OSHA found that "the evidence presented by UWUA members demonstrated that not all electric utility tagging systems work as well as those presented by the EEI witnesses" (59 FR 4354). Finally, the Agency found that "the emergence of new types of companies [footnote omitted] into the electric utility industry and extending the scope of the standard to other industries will expand coverage of § 1910.269 to employers that might not have the tagging systems that provide the level of safety EEI has testified is common among their member companies" (*id.*).

Third, the current rulemaking record also provides evidence of risk related to inadequate hazardous energy control procedures (Exs. 0002, 0004). Ex. 0002, which is a printout of accidents coded with the keyword "elec utility work" or "e ptd" occurring in the years 1984 through 1997, includes 17 accidents at electric power generation plants or substations coded as a failure of the lockout/tagout procedure in use. The keywords "elec utility work" and "e ptd" capture work on electric power generation, transmission, and distribution installations covered by § 1910.269 or Subpart V. OSHA included substations in this analysis because § 1910.269(d) covers substations at power generation plants and because the procedures used at substations typically follow the same lockout-tagout procedures, using a system operator, used in generation plants. Ex. 0004, an accident database that includes electric power generation, transmission, and distribution accidents for the years 1991 through 1999, includes 53 accidents in electric power generation plants or substations coded with the keyword "lockout," which signifies either a failure to deenergize and lockout or tagout a hazardous

energy source or a failure in lockout-tagout procedures.

Fourth, in the preamble to the 1994 rule, OSHA explicitly rejected EEI's claim "that the elements of hazardous energy control in electric utility operations are so unique that they warrant a completely different set of lockout and tagging requirements" than the general industry lockout-tagout requirements (59 FR 4350). In the rulemaking for the 1994 rule, the Agency examined the six elements of electric utility lockout-tagout procedures that EEI claimed made them unique. The Agency found that those elements also were present in lockout-tagout procedures used in other industries (59 FR 4350–4351), and it is for this reason that the existing standards' lockout-tagout provisions are nearly identical. As such, contrary to EEI's argument, evidence of significant risk in the general industry rulemaking bolsters the finding of significant risk in the 1994 rulemaking.

In making its significant risk argument, EEI relied on a statement in the preamble to the 1994 rulemaking in which OSHA was discussing existing § 1910.269(d)'s system-operator provision. OSHA stated in the preamble that the system-operator provision "recognize[s] lockout and tagout practices that are common in the electric utility industry and that have been successful in protecting employees" (59 FR 4364). EEI asserted that this statement demonstrated that the Agency recognized that electric utility lockout-tagout practices were safe. This assertion is not correct. OSHA did not intend this statement to negate the numerous statements in the preamble that existing industry practices posed a significant risk to workers (59 FR 4349–4364). The industry practice referred to in the preamble statement on which EEI relies was the industry practice in which "the system operator has complete control over hazardous energy sources," not the industry practice of not requiring individual employee control and accountability (59 FR 4364).

EEI also contended that OSHA did not show that "sign-on, sign-off requirements in utility power plants were reasonably necessary to eliminate or reduce a significant [risk] of harm to affected employees" (Ex. 0227). In support of this contention, the association pointed to a Freedom of Information Act (FOIA) request it made asking for documents that show that employees in electric power generation plants are at risk from failure to use personal lockout or tagout devices, or their equivalent. EEI stated that "OSHA admitted that it had no documents that responded to [EEI's] requests" (*id.*). EEI also pointed to the testimony of Mr. James Tomaseski before an administrative law judge in the *Exelon* enforcement case. Mr. Tomaseski testified that "signing on and off a piece of paper would not add to employee safety, and could induce crew members to have a false sense of security" (Ex. 0227; Tr. 906).

OSHA rejects EEI's contention. As explained earlier, OSHA described in the preamble to the 1994 rule the basis for determining that the personal control and accountability requirements were necessary (59 FR 4349–4364). OSHA concluded in that rulemaking, and in the earlier rulemaking on the general industry lockout-tagout standard at § 1910.147 (54 FR 36644, Sept. 1, 1989), that personal protection was fundamental to ensuring employee safety in the control of hazardous energy. Moreover, there was clear evidence in the 1994 rulemaking that personal protection was necessary, including evidence that "work authorizations under [electric utility generation plant] tagging systems had been released under pressure from supervisory personnel or without the knowledge of the employee who held the authorization" (59 FR 4351).

This evidence stands in stark contrast to Mr. Tomaseski's opinion that signing on and off a piece of paper does not increase safety.[464] Similarly, OSHA's response to EEI's FOIA request has no bearing on the Agency's finding in the 1994 § 1910.269 rulemaking, or in this one. The Agency responded as it did because, among other reasons: the FOIA request did not seek documents associated with the § 1910.147 and existing § 1910.269 rulemaking proceedings; during the rulemaking process that preceded the adoption of both § 1910.147 and existing § 1910.269, OSHA examined evidence and determined that individual employee control of energy isolating devices, through the use of personal lockout/tagout devices, was an essential element of an effective energy control procedure; and OSHA limited its FOIA response to certain, specified documents maintained in OSHA's National Office because EEI's counsel declined to pay the statutorily defined costs associated with locating and reproducing records from OSHA area offices, as well as some records identified in the National Office.[465] OSHA, therefore, reaffirms its earlier conclusion that personal protection, in the form of a personal lockout-tagout device or comparable mechanism as required by existing § 1910.269(d)(8)(ii)(D), is reasonably necessary for, and indeed is fundamental to, the protection of employees from the release of hazardous energy.

Finally, EEI asserts that OSHA did not show that the cost of compliance bears any relationship to expected benefits and that OSHA did not consider "the cost of compliance with the sign-on, sign-off principle" (Ex. 0227). OSHA rejects this assertion. As OSHA already explained, the existing standard's lockout-tagout provisions were reasonably necessary to eliminate or reduce a risk of significant harm to affected employees. Moreover, the evidence is clear that there were no substantial increased costs associated with the existing personal control and accountability provisions. According to EEI, it was the industry's practice prior to the promulgation of existing § 1910.269 to "communicat[e] orally with each member of the maintenance crew to advise when it is safe to begin work, and to assure that the crewmembers have been notified and are clear of all equipment when the job is complete" (*id.*). The time it currently takes the principle authorized employee to communicate with each authorized employee should be approximately equal to the time it would take the individual authorized employee to sign in or sign out, or attach or remove a tagout device, at the work location. Thus, the Agency did not account for substantial increased costs for this provision because there was no evidence in the 1994 § 1910.269 rulemaking record to indicate otherwise.

EEI's contrary belief that requiring each authorized employee to take an affirmative, physical action, such as attaching a tagout device or signing on and off a work order, would result in a substantial increase in cost is

[464] EEI also fails to explain the basis of Mr. Tomaseski's belief. At the 2005 public hearing on the Subpart V proposal, Mr. Tomaseski testified that "[r]equiring a personal action such as signing on and off a work permit does nothing to ensure the equipment to be worked on is actually safe to work on. A walkdown of the equipment and the principal isolation points will verify that switching has been performed, the lockout/tagout devices are installed, and the equipment is safe to work on. OSHA should incorporate these changes into Paragraph (d)" (Tr. 906–907). OSHA addresses Mr. Tomaseski's concern about verification later in this section of the preamble.

[465] The Agency's Docket Office contains the information on which OSHA relied in adopting the lockout-tagout requirements in the § 1910.147 and 1994 § 1910.269 rulemakings; the Docket Office provides the public with access to the rulemaking record during normal business hours. This docket is also available, on a limited basis, at *http://www.regulations.gov* in Docket ID OSHA–S015–2006–0645.

unreasonable. Relying on a 2003 letter from Exelon to OSHA, EEI asserted that "compliance with the tagging requirements specified in [CPL 02–01–038] would cost more than $6 million annually in Exelon's ten nuclear powered generation plants alone" and that, extrapolated to the entire industry, the cost would be more than $100 million (Ex. 0227). Relying on the Exelon letter is problematic. As OSHA explained in its response to this letter:

> OSHA does not agree that compliance with the provisions in § 1910.269(d) that require individual authorized employees to take an affirmative and physical step prior to authorizing the re-energization of machines or equipment is necessarily as costly as you describe. While the computer terminal method that you describe may permit the requisite degree of employee control, so too would significantly simpler approaches, which would cost little, if anything, to implement.
>
> Indeed, in the Exelon litigation to which you refer, the Secretary of Labor claimed that Exelon's energy control procedure, as described, was deficient in only one respect. The deficiency was that Exelon allowed a supervisor to authorize the re-energization of equipment or machinery on behalf of individual authorized employees after orally accounting for the employees and checking off the employees' names on a Worker Tagout Tracking List (WTTL). During the litigation, the Secretary clearly and repeatedly stated that the same procedure would permit the requisite degree of employee control, if amended slightly to require that each individual employee sign the WTTL before beginning work and sign off the WTTL to authorize re-energization of the machinery after completing work. This minor modification would produce the individual employee accountability and control mandated by the standard. [June 13, 2003, letter of interpretation to Mr. Robert J. Fisher [466]]

As such, Exelon apparently overestimated the cost of compliance because there are less expensive means of compliance available.[467]

Thus, EEI's attacks on the 1994 rulemaking record are without basis. EEI provided no new evidence to invalidate OSHA's conclusion that the standard's personal control and accountability requirements are necessary and appropriate. For these reasons, OSHA is denying EEI's request to remove the personal control and accountability requirements from § 1910.269.

2. EEI asserted that the Agency should eliminate from the final standard the concept that a system operator may place tags for servicing and maintenance employees where energy controls are in a central location under the exclusive control of the system operator because those conditions are not present in electric generation plants. Existing § 1910.269(d)(8)(v) applies where "energy isolating devices are installed in a central location and are under the exclusive control of a system operator." OSHA promulgated the existing system-operator provision because OSHA found in the 1994 § 1910.269 rulemaking that "the only concept employed by electric utilities that is unique to their industry is the use of central control facilities" (59 FR 4364). According to EEI, OSHA intended "to craft a provision that endorsed longstanding utility power plant practices, [but] made a fundamental error, apparently due to a lack of understanding of the power plant environment" (Ex. 0227). EEI also describes OSHA's use of the term "central control facilities" in the 1994 preamble as "baffling." (*id.*).

OSHA denies EEI's petition to revise the existing system-operator provision. First, the Agency's use of the term "central control facilities" in the 1994 preamble was not "baffling." From the language adopted in the introductory text to existing § 1910.269(d)(8)(v), it is apparent that the Agency intended the term "central control facilities" to mean facilities "where energy isolating devices are installed in a central location and are under the exclusive control of a system operator." As OSHA stated in the preamble:

> Under paragraph (d)(8)(v), the system operator has complete control over hazardous energy sources that endanger employees maintaining or servicing machinery or equipment associated with an electric power generation installation. Other employees do not even have access to the energy control devices and cannot operate them to reenergize machinery or equipment being serviced. [59 FR 4364]

Second, OSHA based its decision to incorporate a system-operator provision into the existing standard on the 1994 rulemaking record. An EEI videotape showed a "control room operator" working in what appears to be an isolated control room, with the ability to turn off equipment at a master switch, although the employer also used additional tags for local deenergization procedures (269-Ex. 12–6). Furthermore, the 1987 NESC, in Rule 170, required that circuit breakers, reclosers, switches, and fuses be accessible only to persons qualified for operation and maintenance (269-Ex. 2–8).

If it was not widespread practice in the electric utility industry to have energy controls in a central location under the exclusive control of a system operator, then the existing provision would apply to a narrower class of installations than the class of installations OSHA believed existed during the 1994 rulemaking. There is evidence in the record in this rulemaking that indicates that there are at least some locations in electric power generation plants to which existing § 1910.269(d)(8)(v) could apply. (See, for example, Ex. 0480, "Switchboard operators (or individuals with similar job classifications) control the flow of electricity from a central point [emphasis omitted]," and the "control room operator may have exclusive control of some energy isolating devices within the control room.")

Note that, in adopting existing § 1910.269(d)(8)(v), OSHA retained the fundamental precept that requires "a procedure that affords employees a level of protection equivalent to that provided by the implementation of a personal lockout or tagout device" (paragraph (d)(8)(v)(A).) Consequently, even if OSHA were to accede to EEI's request to broaden the scope of the system-operator provisions, existing paragraph (d)(8)(v)(A) still requires the same measures to which the association objects in existing paragraph (d)(8)(ii)(D).

For these reasons, OSHA is not adopting EEI's recommendation to expand the scope of the existing system-operator provisions in final § 1910.269(d)(8)(v).

3. EEI asserted that OSHA should remove the existing requirement that group lockout-tagout procedures must afford a level of protection equivalent to that provided by the implementation of a personal lockout-tagout device because the Agency did not provide the basis for this comparison.

The existing rule provides an interpretation of "protection equivalent to a personal lockout or tagout device." Accordingly, to provide equivalent protection, a group lockout-tagout program must contain either the elements required by existing § 1910.269(d) for protection associated with the use of personal lockout or tagout devices or elements that are equivalent to the elements required by existing § 1910.269(d) for protection associated with the use of personal lockout or tagout devices. Thus, for instance, a group lockout-tagout program must provide protection equivalent to the personal control and accountability requirements of existing § 1910.269(d)(6) and (d)(7). OSHA framed this requirement in performance terms because the existing group lockout-tagout provisions offer a

[466] This letter of interpretation is available at *http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=24548.*

[467] EEI also did not adequately explain the basis for Exelon's estimated costs.

compromise that balances the need for protection of each authorized employee with the complexity and redundancy involved in many group lockout-tagout situations. (In its response to IBEW's comment later in this section of the preamble, OSHA further explains this compromise in the context of the existing standard's verification requirement.)

Paragraphs (d)(8)(ii)(A) through (d)(8)(ii)(D) of existing § 1910.269 further clarify the meaning of "protection equivalent to a personal lockout or tagout device." Existing paragraph (d)(8)(ii)(A) requires the employer to vest primary responsibility in an authorized employee for a set number of employees (the group or crew) working under the protection of a group lockout or tagout device. Existing paragraph (d)(8)(ii)(B) requires that the group lockout-tagout procedures provide for the authorized employee to ascertain the exposure status of all individual group members with regard to the lockout or tagout of the machine or equipment. Existing paragraph (d)(8)(ii)(C) requires the employer to assign overall job-associated lockout or tagout control responsibility to an authorized employee designated to coordinate affected work forces and ensure continuity of protection when the servicing or maintenance involves more than one crew, craft, department, or other group. Existing paragraph (d)(8)(ii)(D) requires each authorized employee to affix a personal lockout or tagout device to the group lockout device, group lockbox, or comparable mechanism when he or she begins work and to remove those devices when he or she stops performing service or maintenance on the machine or equipment.

Moreover, the preamble to the 1994 § 1910.269 rule elaborated on personal control and accountability requirements in the existing standard by including the following guidelines:

> (1) Group lockout/tagout procedures must be tailored to the specific operation involved. Irrespective of the situation, the requirements of the final rule specify that each employee performing maintenance or servicing activities be in control of hazardous energy during his or her period of exposure.
>
> (2) The procedures must ensure that each authorized employee is protected from the unexpected release of hazardous energy by personal lockout or tagout devices. No employee may affix the personal lockout or tagout device of another employee.
>
> (3) The use of such devices as master locks and tags are permitted and can serve to simplify group lockout/tagout procedures. For example, a single lock may [be] used on each energy isolating device, together with the use of a lockbox for retention of the keys and to which each authorized employee affixes his or her lock or tag. In a tagging system, a master tag may be used, as long as each employee personally signs on and signs off on it and as long as the tag clearly identifies each authorized employee who is being protected by it.
>
> (4) All other provisions of paragraph continue to apply. [59 FR 4362]

These guidelines make it clear that "each employee performing maintenance or servicing activities be in control of hazardous energy during his or her period of exposure." These guidelines, therefore, provided the basis for determining whether group lockout-tagout procedures afford a level of protection equivalent to that provided by the implementation of a personal lockout-tagout device.

The pre-1994 procedures described by EEI in its comment to this rulemaking, and in the videotape discussed earlier in this section of the preamble, address many of the aspects of group lockout-tagout required by existing § 1910.269(d) (Ex. 0227; 269-Ex. 12–6). For instance, the procedures described include a maintenance crew supervisor or lead maintenance worker holding the "clearance" for the group, which EEI calls a "crew" (Ex. 0227). This employee, who can serve as the primary authorized employee called for in existing paragraph (d)(8)(ii)(A), "assure[s] that the crewmembers have been notified and are clear of all equipment when the job is complete and the equipment is to be re-energized," as required by existing paragraph (d)(8)(ii)(B) (*id.*). The system operator described by EEI and seen in the videotape prepares "a list of energy control devices . . . that must be operated to de-energize the equipment to be worked on" and then gives the list to an operations employee, who, functioning as a system operator, "performs the actions necessary to assure de-energization, and applies the warning tags in the specified locations" (*id.*). The system operator also coordinates with the principle authorized employee, through mechanisms such as a master tag with the principle authorized employee's signature or similar device, to help prevent reenergization of hazardous energy while employees are working, even under conditions involving multiple crews (Ex. 0227; 269-Ex. 12–6). An employer can use these system-operator functions to comply with existing paragraph (d)(8)(ii)(C). Apparently, the only facet of "protection equivalent to a personal lockout or tagout device" that EEI finds troubling is the personal control and accountability requirements in the introductory text to existing paragraph (d)(8)(ii) and in existing paragraph (d)(8)(ii)(D). Consequently, the Agency is denying EEI's petition to the extent that EEI seeks removal of the existing requirement that group lockout-tagout procedures afford a level of protection equivalent to that provided by the implementation of a personal lockout-tagout device.

4. EEI asserted that OSHA abused its discretion in elaborating on the meaning of existing § 1910.269 in its compliance directive (CPL 02–01–038). In this regard, EEI stated that "the requirements of the standard should be clearly evident from its text" and that there should be "no justification for continuing to rely on Appendix B to [CPL 02–01–038] after this rulemaking is completed" (Ex. 0227). EEI stated further that "any 'clarifications' that are needed should be accomplished in the text of the rule itself" (*id.*).

The Occupational Safety and Health Review Commission in *Exelon Generating Corp.*, 21 BNA OSHC 1087 and the United States Court of Appeals for the District of Columbia Circuit in *EEI v. OSHA,* 411 F.3d 272 rejected EEI's assertions regarding the meaning of both existing § 1910.269 and the § 1910.269 directive. In *Exelon,* the Commission stated that "[t]he plain wording of . . . § 1910.269(d)(8)(ii)(D) . . . clearly and explicitly mandates use of a personal tagout device in a group tagging situation.. . . Accordingly, we reject Exelon's contention that the group tagging requirements of the standard are confusing or unclear" (21 BNA OSHC at 1090). Moreover, in rejecting EEI's challenge to the § 1910.269 directive, the D.C. Circuit stated:

> EEI's first contention is that the 2003 Directive constitutes a change from the Power Generation Standard because neither the text of the 1994 Standard, nor that of the preamble accompanying it, requires that maintenance employees working in a group "exercise personal accountability by affixing personal locks or tags or their equivalent to energy control devices." Pet'r Br. at 33. But this contention is simply incorrect. The 1994 Standard expressly states that, "[w]hen servicing or maintenance is performed by" a group, "[e]ach authorized employee shall affix a *personal* lockout or tagout device . . ., or comparable mechanism, when he or she begins work and shall remove those devices when he or she stops working." 29 C.F.R. § 1910.269(d)(8)(ii)(D) (emphasis added). That provision reflects OSHA's view, as stated in the 1994 preamble, that "the only way to ensure that the employee is aware of whether or not the lockout or tagout device is in place is to permit only that employee to remove the device himself or herself." 59 Fed.Reg. at 4360; *see id.* at 4361 ("[E]ach employee in the group needs to be able to affix his/her personal lockout or tagout

system device as part of the group lockout." (quoting 54 Fed.Reg. 36,644, 36,681–82 (Sept. 1, 1989))). Indeed, in announcing the 1994 Standard, OSHA expressly rejected "EEI['s] argu[ment] that the person removing a lockout or tagout device need not be the same as the person who placed it," and instead adopted the position that "each employee must have the assurance that the device is in his or her control, and that it will not be removed by anyone else except in an emergency situation." *Id.* at 4360; *see also id.* at 4361 ("The authorized employee in charge of the group lockout or tagout cannot reenergize the equipment until each employee in the group has removed his/her personal device." (quoting 54 Fed.Reg. at 36,681–82)). [footnote omitted]

EEI's second argument is that the 2003 Directive changes the Power Generation Standard by adding, for the first time, a definition of the term "central location under the exclusive control of a system operator" that assertedly alters the term's original meaning. The term plays a key role in the system operator exception to the general requirements of the Power Generation Standard. Under the 1994 Standard, the exception applies only when "energy isolating devices are installed in a central location and are under the exclusive control of a system operator." 29 C.F.R. § 1910.269(d)(8)(v). In such circumstances, the "system operator" may "place and remove lockout and tagout devices in place of" the individual maintenance employee. *Id.* § 1910.269(d)(8)(v)(B).

The 2003 Directive defines this key term as an "area to which access by employees, other than the system operator, to energy isolating devices is physically limited." 2003 Directive at A–2. It further explains that the system operator exception applies only when the "system operator has complete control over the hazardous energy sources because no other employees have access to the area and its energy control devices." *Id.* According to EEI, this definition marks a dramatic change from the Power Generation Standard, because it limits the system operator exception to cases in which the operator is the only employee with *physical access* to the equipment. By contrast, in EEI's view the 1994 Standard permits a supervisor to place and remove locks and tags for other employees whenever the supervisor has exclusive *administrative control* over the machinery under repair—i.e., whenever the system operator is the only person authorized to operate the equipment.

But what EEI calls a "new definition," Pet'r Br. at 21, is in fact a near-verbatim recitation of the text of the 1994 preamble. *Compare* 2003 Directive at A–2 ("The system operator has *complete control over the hazardous energy sources* because no other employees have *access to the area and its energy control devices.*" (emphasis added)), *with* 59 Fed.Reg. at 4364 ("Under [the system operator exception], the system operator has *complete control over hazardous energy sources*. . . . Other employees do not even have *access to the energy control devices* and cannot operate them." (emphasis added)). And the preamble's insistence that the system operator have "complete control" because "[o]ther employees do not even have access to the energy control devices," *id.* at 4364, strongly supports the directive's focus on physical control. [411 F.3d 278–80; emphasis included in original]

As such, the § 1910.269 directive was not a "mandatory regulatory" requirement, as EEI alleges (Ex. 0227). For all of the foregoing reasons, OSHA is denying EEI's petition to revise the group lockout-tagout and system-operator provisions in existing § 1910.269(d).

IBEW also recommended changes to the lockout-tagout provisions in § 1910.269(d). First, as noted earlier, IBEW recommended that OSHA replace the term "system operator" with "control room operator" (Ex. 0230).

The Agency rejects IBEW's first recommendation for the reasons given in the summary and explanation for final § 1926.968, earlier in this section of the preamble.

Second, IBEW recommended that OSHA require the "walk down of principal isolating devices prior to any employee taking any action other than application of a personal lockout/tagout device, including beginning work under a group lockout/tagout application" (*id.*). IBEW questioned why OSHA allows each authorized employee in a group lockout-tagout situation the opportunity to verify the effective isolation of hazardous energy sources, but does not make that action mandatory.[468] The union asked, "If the agency allows another employee to verify this action, how does this provide the same level of protection as the application of a personal lockout/tagout device?" (*id.*).

OSHA rejects IBEW's recommendation. As stated earlier, the standard's group lockout-tagout provisions offer a compromise that balances the need for protection of each authorized employee with the complexity and redundancy involved in many group lockout-tagout situations. Thus, for instance, the group lockout-tagout provisions permit group lockout or tagout devices on energy isolating devices instead of requiring each authorized employee to place individual lockout-tagout devices on each isolating device. (final § 1910.269(d)(8)(ii)(D)).

With respect to the verification issue, OSHA believes that IBEW was addressing a letter of interpretation dated January 29, 2002, to Mr. Jack Prestwood of Tampa Electric Company.[469] This letter, in a footnote, states, "While hazardous energy isolation may be accomplished by a single authorized employee (a "primary authorized employee") in a group lockout/tagout scenario, each authorized employee has the right, and must be given the opportunity, to participate in the verification process, regardless of whether the verification ultimately is performed by each authorized employee or by a primary authorized employee." OSHA based its response to Mr. Prestwood on an earlier statement covering the general industry lockout-tagout standard, § 1910.147. OSHA restated the earlier statement in the directive on that standard, CPL 02–00–147, "The Control of Hazardous Energy—Enforcement Policy and Inspection Procedures." That directive states, in part:

> OSHA has recognized the need for an alternative to the verification requirement where complex LOTO operations involve many employees and numerous energy isolating devices. In such situations, the employer may designate a primary authorized employee (PAE), with the responsibility for a set number of employees working under the group LOTO device(s). The primary authorized employee must implement and coordinate the LOTO of hazardous energy sources and verify that the steps taken, in accordance with the specific energy control procedure, have in fact isolated the machine or equipment effectively from the hazardous energy sources.
>
> In addition to the primary authorized employee, each authorized employee participating in the group LOTO must be informed of his right to verify the effectiveness of the lockout measures, and each authorized employee must be allowed to personally verify, if he so chooses, that hazardous energy sources have been effectively isolated. An authorized employee who opts to verify the effectiveness of the isolation measures must perform this verification simultaneously with or after the PAE verifies the accomplishment of energy isolation and after the authorized employee affixes her personal lockout or tagout device to the group LOTO mechanism. These steps must be taken before authorized employees perform servicing/maintenance activities. [CPL 02–00–147]

This alternative to the verification requirement, if properly implemented, is consistent with the standard, but the procedure used must afford employees "a level of protection equivalent to that provided by the implementation of a personal lockout or tagout device" as required by the introductory text to final § 1910.269(d)(8)(ii). To that end, for an employer to properly implement this

[468] Paragraph (d)(6)(vii) of existing § 1910.269 states: "Before starting work on machines or equipment that have been locked out or tagged out, the authorized employee shall verify that isolation and deenergizing of the machine or equipment have been accomplished."

[469] This letter is available at *http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=INTERPRETATIONS&p_id=24005.*

alternative, that employer's group lockout-tagout procedures must ensure that any energy verification performed by a primary authorized employee affords a level of protection equivalent to the protection provided had each authorized employee installed a personal lockout or tagout device on each energy-isolating device. For example, the procedures could provide that the primary authorized employee conducts the appropriate verification for the machine or equipment they will be servicing and effectively communicates the results of the verification to each employee in the group. Thus, OSHA would not consider as adequate, procedures under which the primary authorized employee merely communicates with a group of authorized employees via radio, without verifying that the machinery or equipment employees will be servicing has, in fact, been deenergized and locked or tagged out.

Existing § 1910.269(r)(1)(ii)(B), (r)(1)(iii), (r)(1)(iv), and (r)(1)(v), which apply to line-clearance tree-trimming operations, impose requirements that refer to existing Table R–6, Table R–9, and Table R–10. Those tables in the existing standard set specific minimum approach distances based on voltage. Existing Table R–6 sets minimum approach distances for ac systems; existing Table R–9 sets minimum approach distances for dc systems; and existing Table R–10 applies altitude correction factors to the minimum approach distances in existing Table R–6 and Table R–9.

Table R–6 and Table R–7 in the final rule correspond to existing Table R–6. The two tables in the final rule set minimum approach distances for ac systems based on the highest maximum per-unit transient overvoltage, just as Table R–6 in existing § 1910.269 does.[470] Table R–8 in the final rule, which sets minimum approach distances for dc systems, corresponds to Table R–9 in existing § 1910.269.[471] Table R–5 in the final rule, which sets altitude correction factors, corresponds to Table R–10 in existing § 1910.269.[472] The final rule revises the relevant provisions in § 1910.269(r)(1) by replacing the references to "Table R–6, Table R–9, and Table R–10" with references to "Table R–5, Table R–6, Table R–7, and Table R–8" wherever the former references appear in the existing standard.

Tree trimming industry practice, as reflected in the consensus standard applicable to tree trimming work,[473] is that "[a]ll overhead and underground electrical conductors and all communication wires and cables . . . be considered energized with potentially fatal voltages" (Ex. 0037). However, testimony from tree trimming industry witnesses described situations in which line-clearance tree trimmers would treat power line conductors as deenergized. (See, for example, Tr. 657–658, 665–667, 690–692.) In its posthearing comment, TCIA indicated that a majority of its members would treat all conductors as energized even if they were deenergized (Ex. 0503).

OSHA has a concern that some tree trimming firms might consider conductors deenergized simply because an electric utility told the firms that the lines are deenergized. Paragraph (l)(1)(iii) of § 1910.269 in the final rule provides that "[e]lectric lines and equipment shall be considered and treated as energized unless they have been deenergized in accordance with paragraph (d) or (m) of this section." Tree-trimming firms typically perform line-clearance tree-trimming operations around overhead power distribution or transmission lines; final § 1910.269(m) covers deenergizing these lines. Paragraph (m)(3)(vii) of final § 1910.269 requires that "[t]he employer shall ensure the installation of protective grounds as required by paragraph (n) of this section." However, paragraphs (d), (l), (m), and (n) are not among the paragraphs listed in final § 1910.269(a)(1)(i)(E)(2) as applying to line-clearance tree-trimming operations performed by line-clearance tree trimmers who are not qualified employees. On the other hand, according to final § 1910.269(a)(1)(i)(D), these provisions do apply to work on, or directly associated with, electric power generation, transmission, and distribution installations (that is, installations covered by § 1910.269(a)(1)(i)(A) through (a)(1)(i)(C)). OSHA considers § 1910.269(a)(1)(i)(D) to regulate any work performed to deenergize lines for the protection of employees. Thus, an electric utility or other employer operating an electric power generation, transmission, or distribution installation around which tree-trimming firms are performing line-clearance tree-trimming operations must comply with § 1910.269(d) or (m),[474] as applicable, before the line-clearance tree-trimming firms may consider and treat the lines or equipment involved as deenergized, in accordance with § 1910.269(l)(1)(iii). Note that each line-clearance tree trimming firm must coordinate its work rules and procedures with the work rules and procedures of the host employer as required by § 1910.269(a)(3)(iii).

OSHA revised § 1910.269(r)(5)(iv) to clarify that drop starting of chain saws is prohibited by § 1910.266(e)(2)(vi). Existing § 1910.269(r)(5)(iv) requires employees to start gasoline-engine power saws on the ground or where they are otherwise firmly supported. The existing provision also permits drop starting of power saws weighing more than 6.8 kilograms (15 pounds) outside of the bucket of an aerial lift when the area below the lift is clear of personnel. While paragraph (r)(5) of existing § 1910.269 applies broadly to gasoline-engine power saws, the introductory text to the paragraph requires that power saws meet the requirements of § 1910.266(e), which applies to chain saws only. Paragraph (e)(2)(vi) of § 1910.266, which OSHA promulgated after it promulgated existing § 1910.269(r)(5)(iv), prohibits drop starting of chain saws. (See 59 FR 51672, 51712, Oct. 12, 1994.) Thus, existing §§ 1910.266(e)(2)(vi) and 1910.269(r)(5)(iv) together operate to prohibit drop starting of chain saws, but permit drop starting of other types of gasoline-engine power saws weighing over 6.8 kilograms outside of the bucket of an aerial lift when the area below the lift is clear of personnel. OSHA clarified the language of § 1910.269(r)(5)(iv) in the final rule to this effect. In addition, the Agency added a note to that paragraph stating that

[470] Existing § 1910.269(r)(1)(ii)(B), (r)(1)(iii), (r)(1)(iv), and (r)(1)(v) require line-clearance tree trimmers to maintain minimum approach distances based on the highest maximum transient overvoltage. Paragraph (l)(3)(i) of final § 1910.269 requires employers to establish minimum approach distances based on Table R–3 for ac systems. This table contains equations that employers must use to calculate minimum approach distances. Table R–6 and Table R–7 set minimum approach distances based on the highest maximum transient overvoltage. Thus, Table R–6 and Table R–7 in the final rule correspond to Table R–6 in existing § 1910.269.

[471] Table R–8 in the final rule is the same as existing Table R–9 in existing § 1910.269, except that the table in the final rule lists distances in metric units.

[472] Table R–5 in the final rule is the same as Table R–10 in existing § 1910.269, except that the table in the final rule lists altitudes in metric units.

[473] ANSI Z133.1–2000, "American National Standard for Arboricultural Operations—Pruning, Repairing, Maintaining, and Removing Trees, and Cutting Brush Safety Requirements." ANSI Z133–2012 contains the same requirement.

[474] Paragraph (m) contains provisions that the "employee in charge of the clearance" take certain actions. (See, for example, paragraph (m)(2)(iv)(A), which requires, as one of two alternatives for multiple crews working on the same lines, the crews to coordinate their activities with a single employee in charge of the clearance.) OSHA believes that this employee will be an employee of the electric utility or other employer operating the electric power transmission or distribution installation.

§ 1910.266(e)(2)(vi) prohibits drop starting of chain saws.

EEI recommended that, except with respect to lockout-tagout procedures in electric power generation installations, OSHA "incorporate in the final standard the '[c]larifications' that are contained in Appendix B of [CPL 02–01–038]" (Ex. 0227). (See also, Tr. 1171–1175.) Mr. Stephen Yohay, counsel for EEI, testified that doing so would "provide notice of what the law requires, both to employers and employees" and would prevent OSHA from "changing unilaterally" its directive (Tr. 1174).

OSHA decided not to adopt EEI's recommendation (except with respect to the issue of network protectors described in the summary and explanation for final § 1926.961(c)(4), earlier in this section of the preamble). First, some of the statements in CPL 02–01–038 are moot because of the changes made to § 1910.269. For example, revisions to the requirements on fall protection in the final rule, described in the summary and explanation of § 1926.954(b)(3)(iii) earlier in this section of the preamble, make some of the statements in the directive inconsistent with the requirements in the final rule. When OSHA issues a directive on the final rule, it will address the requirements in the final rule.

Many of the remaining statements in Appendix B to CPL 02–01–038 are in accord with final § 1910.269. For example, a statement regarding temporary protective grounds notes that the term "temporary protective grounds" in existing § 1910.269(n)(3) refers to grounds placed temporarily and explains that employers can use fixed, as well as portable, grounds to meet this provision. In any event, EEI's concern that OSHA will make changes to such statements through future directives is speculative, and EEI has no grounds to challenge the directive, as it is not a standard.

2. Section 1910.132

Paragraph (d) of § 1910.132 addresses hazard assessment and selection of personal protective equipment. Paragraph (f) of § 1910.132 addresses training in the use of personal protective equipment. As noted in § 1910.132(g), paragraphs (d) and (f) of existing § 1910.132 do not apply to electrical protective equipment covered by § 1910.137. While other electrical standards cover training (for example, in § 1910.268, Telecommunications, in § 1910.269, Electric power generation, transmission, and distribution, and in § 1910.332, Training in electrical safety-related work practices), other OSHA electrical standards do not address many of the hazard-assessment requirements in § 1910.132(d). In the preamble to the proposed rule, OSHA requested comments on whether it should add electrical protective equipment to the scope of § 1910.132(d) or § 1910.132(f), or both.

One commenter supported adding electrical protective equipment to the scope of the requirements for hazard assessment and selection of PPE in § 1910.132(d), and for training in § 1910.132(f), if no other standard addressed those issues (Ex. 0126).

Other commenters opposed expanding the scope of § 1910.132(d) and (f) to cover electrical protective equipment (Exs. 0177, 0186, 0201, 0209, 0212, 0227). Several of those comments argued that there is no other "special industry equipment in § 1910.132" (Exs. 0177, 0209, 0227).

Section 1910.132 covers all types of PPE regardless of their use only in particular industries. The language of § 1910.132(a) is broad and inclusive of all types of PPE. That section clearly covers electrical protective equipment under § 1910.137 in Subpart I, Personal Protective Equipment. Even assuming that these commenters meant only that paragraphs (d) and (f) of § 1910.132 do not cover "special industry equipment," the commenters' rationale is not valid. OSHA does not consider electrical protective equipment to be under the exclusive domain of the electric power industry. OSHA standards having general applicability to all of general industry require this type of PPE (see Subpart S of Part 1910). Paragraph (a)(1)(i) of § 1910.335 requires that "[e]mployees working in areas where there are potential electrical hazards . . . be provided with, and shall use, electrical protective equipment that is appropriate for the specific parts of the body to be protected and for the work to be performed."

Southern Company argued that adding electrical protective equipment to the scope of § 1910.132(d) and (f) would appear to offer few benefits (Ex. 0212). The company maintained that electrical protective equipment has little in common with other types of PPE because the selection of the type of rubber insulating equipment depends on many factors, such as the work methods involved and the worksite configuration.

OSHA disagrees that electrical protective equipment is unique with respect to the number of factors involved with its selection. Whether other types of PPE are necessary also depends on the work methods and worksite configuration involved. For example, whether foot protection is necessary depends on both the work methods in use and the worksite configuration. Foot protection typically is necessary when employees carry or handle materials such as packages, objects, parts, or heavy tools that the employees could drop or when objects in the work area could potentially roll over an employee's feet. (See Appendix B to Subpart I of Part 1910.) Additionally, OSHA believes that the many factors that go into the decision of whether to use electrical protective equipment and what types of equipment to use argue for adding this type of equipment to the scope of § 1910.132(d) and (f). The more difficult the decision-making process, the more important it is for employers to train workers adequately and for employers to adopt a more formal process for selecting PPE.

Two of the commenters opposing the addition of electrical protective equipment to the scope of § 1910.132(d) and (f) disputed the need to do so (Exs. 0186, 0201). These two commenters maintained that training and hazard assessment are addressed adequately in existing standards. Duke Energy stated that § 1910.269 addresses training and assessment (Ex. 0201). Mr. Anthony Ahern with Ohio Rural Electric Cooperatives commented that changing the scope of § 1910.132 would be unnecessarily duplicative (Ex. 0186).

The Agency agrees with these commenters. The electrical standards in §§ 1910.268(c), 1910.269(a)(2) (which OSHA is revising in this rulemaking), and 1910.332 require training that will ensure that employees know how to properly use and care for electrical protective equipment. These standards also contain several explicit requirements mandating the use of electrical protective equipment. These training and specific electrical protective equipment requirements clearly reduce, if not eliminate, the need to cover hazard assessment and training in § 1910.132. Thus, the Agency agrees with Mr. Ahern that adding electrical protective equipment to the scope of § 1910.132(d) and (f) would be unnecessarily duplicative. Consequently, OSHA decided against doing so.

NAM objected to adding arc-flash hazard assessment or protective clothing to the scope of § 1910.132(d) and (f) (Ex. 0222).

OSHA neither proposed adding, nor requested comments on whether it should add, arc-flash hazard assessment or protective equipment needed to protect against arc-flash hazards to the scope of § 1910.132(d) or (f). The preamble request for comments

addressed specifically electrical protective equipment covered by § 1910.137. In this final rule, the Agency is explicitly requiring employers to assess the hazards of flames and electric arcs only for work covered by § 1910.269(l) or § 1926.960. Therefore, OSHA finds no basis in NAM's concerns that the Agency is expanding the hazard-assessment and training requirements related to electric-arc hazards beyond the requirements contained in § 1910.269 and Subpart V. (See also the summary and explanation of final § 1926.960(g), earlier in this section of the preamble, for further discussion of issues related to protection of workers from electric arcs.)

3. Section 1910.136

OSHA proposed to revise § 1910.136(a), in addition to the proposed new § 1926.97 and the proposed revisions to § 1910.137, § 1910.269, and Subpart V. Existing § 1910.136(a) states that the employer must ensure that each affected employee uses protective footwear when working in areas where there is a danger of foot injuries due to falling or rolling objects, or objects piercing the sole, and where such employee's feet are exposed to electrical hazards.

In the preamble to the proposal, the Agency expressed concern that the regulated community was interpreting this language to recognize the use of electrical-hazard footwear as a primary form of electrical protection (70 FR 34893).[475] Manufacturers construct electrical-hazard footwear to provide insulation of the wearer's feet from ground. While this footwear can provide the wearer a small degree of protection from electric shock at 600 volts or less under dry conditions, the footwear is only a secondary form of electrical insulation. Conductive footwear, which is not electrical-hazard footwear, prevents static electricity buildup.[476] This is one method of protecting against static electrical discharges that can damage equipment or, in hazardous locations, could possibly lead to fires or explosions.

In the preamble to the proposal, OSHA explained that the use of electrical-hazard footwear as a primary form of electrical protection could expose workers to electric-shock hazards if they believe that the primary forms of electrical protection (for example, rubber insulating gloves or blankets) are no longer necessary (*id.*). First, electrical-hazard footwear only insulates an employee's feet from ground. The employee still might be grounded through other parts of his or her body. Second, the insulation provided by electrical-hazard footwear is effective only under dry conditions; this footwear provides little, if any, protection once it becomes wet or damp. Lastly, the voltage rating on electrical-hazard footwear is only 600 volts. Therefore, OSHA proposed to delete language relating to electrical hazards from § 1910.136(a). In the proposal, this paragraph read as follows:

(a) *General requirements.* The employer shall ensure that each affected employee uses protective footwear when working in areas where there is a danger of foot injuries due to falling or rolling objects or due to objects piercing the sole.

OSHA decided not to incorporate the proposed language into the final standard. Many commenters supported the proposed removal of the language in § 1910.136(a) relating to electrical hazards. (See, for example, Exs. 0183, 0202, 0206, 0229, 0233.) These commenters agreed with the rationale OSHA provided in the preamble to the proposed rule, and some noted that this type of footwear is not designed for outdoor environments or rated for the voltages encountered in electric power distribution work.

Three commenters opposed the complete removal from existing § 1910.136(a) of language addressing electrical hazards (Exs. 0105, 0123, 0148). These commenters mentioned ASTM F1116, *Standard Test Method for Determining Dielectric Strength of Dielectric Footwear,* and F1117, *Standard Specification for Dielectric Footwear,* as examples of consensus standards for footwear that provides primary protection against electric shock. Comments from Norcross Safety Products, LLC, and LaCrosse Footwear noted that OSHA recognizes the need for electric power workers to use dielectric footwear,[477] but stated that the proposed removal of protection against electrical hazards[478] would reduce protection for workers outside the electric power industry (Exs. 0105, 0123). These commenters indicated that an employer should base the need for footwear to protect against electrical hazards on the employer's job-safety assessment.

Paragraph (d) of § 1910.132 requires employers to assess their workplaces "to determine if hazards are present, or are likely to be present, which necessitate the use of personal protective equipment," and to provide PPE in accordance with that assessment. As noted previously, § 1910.132(g) restricts the application of § 1910.132(d) to PPE covered by §§ 1910.133 (eye and face protection), 1910.135 (head protection), 1910.136 (foot protection), and 1910.138 (hand protection). Thus, OSHA's existing standards require the hazard assessment recommended by Norcross and Lacrosse. However, if the Agency adopted the proposed removal of electrical-safety footwear (that is, electrical-hazard, dielectric, and conductive footwear) from § 1910.136(a), the requirement in § 1910.132(d) for employers to perform a hazard assessment would no longer apply to electrical-safety footwear.

On the other hand, OSHA believes that, because of its limitations, electrical-hazard and dielectric footwear should only be required by § 1910.136 as a supplementary form of electrical protection. The Agency also believes that conductive footwear, whether or not it provides protection for the foot, is supplementary protection to be used when flammable gases or vapors or combustible dusts cannot be adequately controlled. Consequently, OSHA is revising the language in § 1910.136(a) to require the employer to ensure that each affected employee uses protective footwear (1) when working in areas where there is a danger of foot injuries due to falling or rolling objects, or objects piercing the sole, or (2) when the use of protective footwear will protect the affected employee from an electrical hazard, such as a static-discharge or electric-shock hazard, that remains after the employer takes other necessary protective measures.

In addition, OSHA is revising nonmandatory Appendix B to Subpart I to include a passage in section 10 of that appendix indicating that electrically

[475] Primary insulation normally insulates an employee directly from an energized part. Rubber insulating gloves and rubber insulating blankets are examples of primary electrical protection. Secondary insulation normally insulates an employee's feet from a grounded surface. Electrical-hazard footwear and rubber insulating matting are examples of secondary electrical protection.

[476] ANSI Z41–1999, *American National Standard for Personal Protection—Protective Footwear,* which is incorporated by reference in existing §§ 1910.6 and 1910.136, covers electrical-hazard and conductive footwear.

[477] ASTM F1117 describes dielectric footwear as "footwear designed to provide additional isolation or insulation of workers if in accidental contact with energized electrical conductors, apparatus, or circuits." This ASTM standard covers three types of footwear: rubbers, boots, and galoshes. Dielectric footwear, which is proof tested at 15 or 20 kilovolts, ac, provides better electric shock protection than electrical-hazard footwear, which is rated at 600 volts, maximum.

[478] "Electrical hazards" as used in the discussion of protective footwear in this preamble and in existing § 1910.136(a) means electric shock hazards and hazards from the discharge of static build up. There are three types of footwear that protect against electrical hazards, that is, conductive, electrical-hazard, and dielectric footwear.

conductive shoes would be required as a supplementary form of protection for work activities in which there is a danger of fire or explosion from the discharge of static electricity. The passage also states that electrical-hazard or dielectric footwear would be required as a supplementary form of protection when an employee standing on the ground is exposed to hazardous step or touch potential (the difference in electrical potential between the feet or between the hands and feet) or when primary forms of electrical protective equipment, such as rubber insulating gloves and blankets, do not provide complete protection for an employee standing on the ground.

The same three commenters who opposed the complete removal from existing § 1910.136(a) of language addressing electrical hazards also noted that existing § 1910.137 did not specifically mention dielectric footwear covered by ASTM F1116 and F1117 (Exs. 0105, 0123, 0148). These commenters maintained that this equipment does provide primary protection from electric shock and recommended that OSHA require such protection either in § 1910.136, § 1910.137, § 1926.97, or Subpart V. Norcross submitted specific suggestions for revising § 1910.137 to address dielectric footwear (Ex. 0105).

OSHA considers dielectric footwear to be electrical protective equipment, which is covered by §§ 1910.137 and 1926.97 of the final rule, in addition to being protective footwear covered by § 1910.136.[479] It is true that final §§ 1910.137(a) and 1926.97(a) explicitly limit their coverage to rubber insulating blankets, matting, covers, line hose, gloves, and sleeves and thus do not cover dielectric footwear. However, final §§ 1910.137(b) and 1926.97(b) cover "the design and manufacture of electrical protective equipment that is not covered by paragraph (a)," including dielectric footwear. OSHA has examined the revisions to § 1910.137 suggested by Norcross and concludes that the requirements adopted in § 1910.137(a) are not and should not be applicable to dielectric footwear. The Agency has also concluded that it is more appropriate to cover this equipment in § 1910.137(b). In addition, OSHA does not agree that dielectric footwear is primary electrical protection. ASTM F1117–03 covers dielectric footwear "designed to provide *additional* isolation or insulation of workers" from electric shock (Ex. 0105; emphasis added). Thus, ASTM recognizes that dielectric footwear is supplementary, not primary, protection. Consequently, OSHA is not adopting the recommendation of these commenters to add specific requirements for dielectric footwear in § 1910.137.

4. Part 1910, Subpart S Revisions

As noted earlier, OSHA revised the definition of "line-clearance tree trimming" in § 1910.269(x). Changing the definition broadens the scope of § 1910.269 with respect to tree-trimming operations performed near electric supply lines and equipment energized at more than 50 kilovolts. This change also impacts the scope of the requirements for electrical safety-related work practices in Subpart S of the general industry standards. Note 3 to § 1910.331(c)(1) indicates that §§ 1910.332 through 1910.335 do not apply to qualified employees performing line-clearance tree trimming operations. Section 1910.399 defines "line-clearance tree trimming," using language that is identical to the language in existing § 1910.269(x), even though that term is used in Subpart S only in Note 3 to § 1910.331(c)(1). OSHA determined that the meaning of "line-clearance tree trimming" must be the same in § 1910.269 and Subpart S to ensure that there are no gaps or overlaps in coverage between the two standards with respect to tree-trimming operations performed by line-clearance tree trimmers (who are qualified employees under Subpart S) near electric supply lines and equipment operating at more than 50 kilovolts. Therefore, the Agency is removing the definition of "line-clearance tree trimming" from § 1910.399 and is adding, to Note 3 of § 1910.331(c)(1), a reference to the definition of that term in § 1910.269(x).

D. Part 1926, Removal of Incorporations by Reference

As explained earlier in this section of the preamble, the final rule removes the incorporation by reference of several consensus standards. OSHA is revising existing § 1926.6, which provides notification of approval of incorporations by reference by the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR Part 51. In this regard, OSHA is removing and reserving paragraphs (h)(17), (h)(18), (h)(19), (h)(20), (h)(21), (h)(22), and (j)(2), which list the approval of the incorporation of ANSI standards that are no longer incorporated in final Subpart V.

E. Part 1926, Subpart CC Revisions

OSHA's revised standard for cranes and derricks at Subpart CC of Part 1926 contains provisions that reference existing § 1910.269. Paragraph (g) of existing § 1926.1400 provides that, for work covered by Subpart V of Part 1926, OSHA will deem employers complying with existing § 1910.269(p) as in compliance with §§ 1926.1407 through 1926.1411 of Subpart CC. Because requirements for the operation of mechanical equipment are the same in both final § 1910.269 and final Subpart V, OSHA is revising these references in Subpart CC of Part 1926 to refer to the corresponding provisions in Subpart V of Part 1926.

In addition, Subpart CC contains provisions that apply when employers perform Subpart V work with cranes or derricks closer to overhead power lines than the minimum clearance distances in Table V–1 of existing Subpart V. First, existing § 1926.1410(c)(2) permits an employer engaged in Subpart V work to work closer than the distances in existing § 1926.950 Table V–1 where the employer meets both the requirements of § 1926.1410 and existing § 1926.952(c)(3)(i) or (c)(3)(ii). Second, existing § 1926.1410(d)(4)(ii) provides that, for work covered by Subpart V, existing § 1926.1410(d)(4)(i), which requires the use of an insulating link or device, applies only when working inside the existing Subpart V, Table V–1 clearance distances. Finally, existing § 1926.1410(d)(4)(iii) provides that, for work covered by Subpart V of Part 1926 involving operations for which use of an insulating link/device is infeasible, employers may substitute the requirements of existing § 1910.269(p)(4)(iii)(B) or (p)(4)(iii)(C) for the requirement in existing § 1926.1410(d)(4)(i).

As noted in the summary and explanation for final § 1926.959(d)(1) earlier in this section of the preamble, Subpart V requires that employers ensure that employees do not take mechanical equipment, except for the insulated portion of an aerial lift operated by a qualified employee, inside the minimum approach distance, established by the employer under § 1926.960(c)(1)(i). Consequently, the requirements in existing § 1926.1410(c)(2), (d)(4)(ii), and (d)(4)(iii) that pertain to the operation of cranes and derricks inside the minimum approach distance, are no longer applicable. Therefore, OSHA is removing those requirements from Subpart CC. However, OSHA is retaining the paragraph (d)(4)(ii) exemption from § 1926.1410(d)(4)(i) for

[479] OSHA notes that § 1926.96, which incorporates requirements for occupational foot protection used in construction work, applies to safety-toe footwear only. That section does not apply to electrical-safety footwear except to the extent that it is also safety-toe footwear.

Subpart V work. Also, OSHA is replacing the phrase "the minimum clearance distances specified in § 1926.950 Table V–1" with "the minimum approach distances established by the employer under § 1926.960(c)(1)(i)" to reflect the changes made to the minimum approach distances required by § 1926.960(c)(1) in this final rule.

VI. Final Economic Analysis and Regulatory Flexibility Analysis

A. Introduction

The OSH Act requires OSHA to demonstrate that standards promulgated under the Act are technologically and economically feasible. Executive Order 12866 and 13563 and the Regulatory Flexibility Act, 5 U.S.C. 601 *et seq.*, require Federal agencies to estimate the costs, assess the benefits, and analyze the impacts, including small business impacts, of their rules. Executive Orders 12866 and 13563 direct agencies to assess all costs and benefits of available regulatory alternatives and, if regulation is necessary, to select regulatory approaches that maximize net benefits (including potential economic, environmental, public health and safety effects, distributive impacts, and equity). Executive Order 13563 states that the Federal regulatory system "must take into account benefits and costs" and "reduce burdens and maintain flexibility and freedom of choice." OSHA determined that this action is economically significant within the meaning of Section 3(f)(1) of Executive Order 12866 because it is likely to have an effect on the economy of $100 million or more in any 1 year. This final rule is also a major rule under the Congressional Review Act, 5 U.S.C. 801 *et seq.* The Office of Information and Regulatory Affairs in the Office of Management and Budget reviewed this final rule. As required by the Regulatory Flexibility Act, OSHA assessed the impacts of this final rule on small entities and prepared a Final Regulatory Flexibility Analysis.

This is the Final Economic Analysis and Regulatory Flexibility Analysis (FEA) for OSHA's update of the standards addressing electric power generation, transmission, and distribution work, and the use of electrical protective equipment. This analysis covers all elements of this present rulemaking, including changes to 29 CFR Part 1910 and changes to 29 CFR Part 1926. OSHA analyzed the consolidated set of actions in its entirety; only portions of the standards identified as involving nonnegligible costs are explicitly reflected in the analysis of compliance costs and impacts. This FEA includes a discussion of all the specific comments OSHA received on the PRIA in support of the proposed rule, including comments received on OSHA's assumptions and estimates. Where OSHA does not note comments or suggestions with respect to an estimate, there were no comments or suggestions. OSHA is including the complete FEA in this **Federal Register** notice.

B. Need for the Rule

Employees performing work involving electric power generation, transmission, and distribution are exposed to a variety of significant hazards, such as fall, electric-shock, and burn hazards, that can and do cause serious injury and death. As detailed later in this section of the preamble, OSHA estimates that, on average, 444 serious injuries and 74 fatalities occur annually among these workers. Although better compliance with existing safety standards may prevent some of these accidents, research and analyses conducted by OSHA found that many preventable injuries and fatalities could continue to occur even if employers fully complied with the existing standards. As the benefits analysis shows, if the final rule can prevent even 10 percent of these fatal and nonfatal accidents, then the benefits of the final rule will exceed its costs. As the same analysis concludes, the final rule will likely prevent far more than 10 percent of these fatal and nonfatal accidents (assuming full compliance with the final rule). Accounting for the probability that some accidents will be prevented by the existing rule, OSHA estimates that the final rule will prevent 118.5 injuries and 19.75 fatalities per year (26.7 percent of all fatal and nonfatal accidents).

Executive Order 12866 provides that "[e]ach agency shall identify the problem that it intends to address [via regulation] including, where applicable, the failures of private markets." OSHA believes it can make a reasonable case that, in the absence of regulations, market failures prevent free markets from providing the levels of occupational safety, and particularly the levels of safety for electrical workers affected by this standard, that would maximize net benefits to society.

Employees and supervisors affected by this rule are frequently trained in, and knowledgeable about, the relevant hazards. Many are also knowledgeable about existing OSHA standards. The primary problem is that contractors, employees, and supervisors frequently lack the information about the specific electrical system and worksite conditions needed to determine what protective measures to take. The most costly provisions of this standard address this problem. As explained in the summary and explanation of the final rule's requirements on information transfer and job briefing (§§ 1926.950(c) and 1926.952(a)(1)), testimony and other information in the record show that key information necessary for taking the appropriate safety measures is sometimes lacking, often with fatal consequences. In addition, as explained in the summary and explanation of the final rule's requirements on minimum approach distances (§ 1926.960(c)(1)), employers frequently adopt minimum approach distances that rely on industry-accepted values of maximum per-unit transient overvoltage rather than the maximum value present at the worksite. The benefits analysis presented under the heading "Benefits, Net Benefits, and Cost Effectiveness," later in this section of the preamble, shows that many accidents are potentially preventable with better information on the electrical system and worksite conditions.

To determine possible market failures that could lead to employers either not providing information to other employers or their own employees, or to not providing other safety measures when the benefits exceed the costs, it is necessary to examine the way employers make decisions with respect to health and safety. When an employee accepts a job with an employer, the employee will typically accept the risks associated with the job in return for two forms of compensation—(1) a wage premium for assuming the risk and (2) compensation for damages in the event the risk actually leads to damages. The rational profit-maximizing employer will make investments in workplace safety to reduce the level of risk to employees to the extent that such expenditures result at least in an offsetting reduction in the employer's payouts of wage premiums for risk and compensation for damages. To the extent that the sum of the costs of wage premiums and compensation for damages accurately represent the total damages associated with workplace accidents, the rational employer will conduct the appropriate economic analysis and arrive at the level of accident prevention that is optimal from a benefit-cost viewpoint. As a result, the possible origins of market failure would be either: (1) There are costs of accidents that are borne neither by the employee or the employer, or (2) the costs of wage premiums or compensation for damages are not fully

responsive to changes in risk. Both cases apply here.

In the first case, there are some accident costs incurred by neither the employer nor the employee. For instance, neither the employer nor the employee will have a vested interest in Federal and State taxes that go unpaid as a result of an employee injury. Such taxes will typically be 15 (for Social Security alone) to 26 percent of the total value of the income loss to the employee [17, 52].[480] Tax losses are likely to be significant because (1) workers' compensation payments are not subject to Federal income or Social Security taxes [16], and (2) many studies found that income losses not compensated by workers' compensation are significant [23].

In the second case, the costs employers pay in compensation for damages, or for wage premiums, are not completely responsive to changes in risk, as discussed in the following paragraphs.

Workers' Compensation

Most employers cover, and are required to cover, compensation for injured employees through workers' compensation insurance. (Some very large employers may self-insure in some States.) States highly regulate premiums for workers' compensation insurance and generally employ a combination of a class rating and an experience rating in deriving premiums [24, 3]. The class rating is the average risk for employees with the same occupations as those employed by the employer. The basis of the experience rating is the employer's actual workers' compensation claims over the past several years. Very small firms are almost entirely class rated; even medium-sized firms are partly class rated; and firms that are fully experience rated will need several years before their insurance premiums fully reflect any change in their performance. As a result, many employers will find that changes in their expenditures to avoid risk are only minimally reflected in changes in their workers' compensation premiums, and all insured employers will find that there is a considerable delay before changes in risk are fully reflected in their workers' compensation insurance premiums. As a result, many employers will not see improvements they make in preventing injuries and illnesses reflected in the costs they bear for compensating employee injuries and illnesses.[481]

Wage Premiums

Wage premiums for risk are the remaining factor that could affect employers' decisions about risk levels. The effects of wage premiums are particularly important for risks that lead to fatalities because workers' compensation covers only a small fraction of most estimates of willingness to pay to prevent a fatality.[482] Additionally, workers' compensation payments do not fully compensate injuries in that workers' compensation provides no payments for pain and suffering or losses other than lost wages or medical expenses associated with injuries; there is extensive evidence that workers' compensation does not fully restore wages lost as result of long-term disability [3]. As a result, wage premiums that accurately reflect the risks of a specific employer are necessary, in addition to workers' compensation, for employers to make valid risk-reduction decisions.

For an employer to have an adequate incentive to implement measures that will prevent workplace accidents, it is not sufficient that employees simply know that their work is dangerous, or even know quantitatively that their occupation has a given risk. Employees must: know the exact quantitative effect of a specific employer's safety measures and systems; have a reasonable expectation that the employer will continue to provide existing safety measures in the future; and be able to act on their knowledge of risk by readily changing workplaces or changing wage demands in response to differences in levels of risk. OSHA believes that even skilled electrical workers (and not all persons injured in accidents preventable by the final rule are skilled electrical workers) lack this detailed employer-specific quantitative knowledge or the ability to act on it. Further, construction employees, who typically work at a variety of different sites, including sites controlled by multiple employers, will find it particularly challenging to determine future risk levels, as these levels will vary from site to site.

In summary, OSHA believes that: (1) The most costly portions of the rule are necessary to assure that supervisors and employees have the information they need to protect themselves; (2) the benefits of this standard exceed the costs; (3) neither employers nor employees incur some key costs of injuries and fatalities; and (4) neither wage premiums nor workers' compensation insurance are sufficiently responsive to changes in risk to assure that employers will reduce risk to the optimal extent. The rule is, therefore, necessary to address market failures that result in the provision of insufficient safety measures in the workplace.

The OSH Act provides a Congressional finding as to the compelling social need for assuring occupational safety. Congress declared that the purpose of the OSH Act is "to assure so far as possible every working man and woman in the Nation safe and healthful working conditions" (29 U.S.C. 651(b)). Thus, it is reasonable to argue that there is a social purpose for this final rule independent of whether or not it addresses a market failure.[483] Further, by emphasizing "every working man and woman," Congress expressed an interest in preventing unsafe workplaces, not simply in assuring that, on average, workplaces are safe. Thus, while some employers are excessively cautious about risk while others are insufficiently cautious, OSHA's concern needs to be with the insufficiently cautious.

C. Examination of Alternative Regulatory Approaches

Under Section 3(8) of the OSH Act, the requirements of an OSHA standard must be "reasonably necessary or appropriate to provide safe or healthful employment and places of employment." To be reasonably necessary or appropriate, a safety standard must be technologically and economically feasible, better able to effectuate the purposes of the OSH Act than any relevant national consensus standards, and use the most cost-effective protective measures.

To determine the appropriate regulatory requirements to address occupational risks for employees working on electric power generation, transmission, and distribution systems, OSHA considered many different factors and potential alternatives. The Agency examined the incidence of injuries and fatalities and their direct and underlying

[480] The average federal tax rate for 2009 for the middle quintile of household income was 11.1 percent [52].

[481] This outcome, of course, involves an accounting point. Premiums due to class rating, by definition, do not change with an individual employer's injury experience. There is some empirical evidence, using a difference in differences methodology, that (small) firms that move from class to experience rating decrease their total claims by 8 to 12 percent [27].

[482] While workers' compensation varies by State, Leigh and Marcin estimate that the average indemnity benefits for a fatality are $225,919, far less than willingness-to-pay estimates [21]. For example, as explained in the benefits section of this analysis, OSHA uses a willingness-to-pay measure of $8.9 million per life saved. Other agencies use different estimates, but all of the values are in the millions of dollars.

[483] See Section IV, Legal Authority, earlier in this preamble, for a detailed discussion of the legal authority for this standard and how the final standard meets the various requirements of the OSH Act as interpreted by the courts.

causes to ascertain where existing standards needed strengthening. OSHA reviewed these standards, assessed current practices in affected industries, collected information and comments from experts, and scrutinized the available data and research. A full discussion of the Agency's rationale for adopting each of the regulatory requirements in the final rule is available in Section V, Summary and Explanation of the Final Rule, earlier in this preamble.

The most costly provisions in the final rule are those requiring employers to conduct arc-flash hazard assessments and provide arc-flash protective equipment appropriate for the identified arc hazards (as required by § 1926.960(g)). OSHA calculated the costs of two alternative regulatory approaches to arc-flash protective equipment. As a less stringent alternative to the final rule, OSHA considered a general requirement for arc-flash protective clothing with an arc rating of 4 cal/cm^2. This alternative would eliminate the costs associated with performing arc-hazard assessments, as well as the costs of providing some types of protective gear, such as switching coats or flash suits, faceshields, and head protection. Under this less stringent alternative, the total annual costs for arc-flash protective clothing would be approximately $15.6 million (instead of $19.4 million for the arc-hazard assessment and arc-flash protective equipment combined), and the total annual cost of the rule would be approximately $45.7 million (instead of $49.5 million).

OSHA also considered the more stringent alternative of requiring affected industries to follow Table 130.7(C)(9) in NFPA 70E–2009, *Standard for Electrical Safety in the Workplace*. This approach would obviate the need for employers to do arc-hazard assessments, but would result in affected workers needing protective clothing with a higher arc rating, and a higher percentage of power workers[484] needing to use arc-rated faceshields and head protection (80 percent of power workers at small establishments and 90 percent of power workers at large establishments, as opposed to 13 percent under the rule as adopted). The cost for switching coats or flash suits would remain unchanged under the more stringent alternative.

To analyze the costs of requiring clothing with a higher arc rating under the NFPA approach, OSHA estimated that a coverall with an arc rating of 8 cal/cm^2 costs $191.75 [13],[485] while the equivalent piece of clothing with an arc rating of 12 cal/cm^2 costs $290.50 [14], for an incremental cost of $98.75 per item.[486] With eight sets of flame-resistant clothing[487] per affected worker, this results in incremental annualized costs of approximately $8.0 million. Adding these costs to the $15.6 million in annualized costs for flame-resistant clothing under the provisions of the final rule results in total annualized costs for flame-resistant clothing of approximately $23.7 million.

OSHA calculated the costs for arc-rated faceshields and head protection as described under the heading "Costs of Compliance," later in this section of the preamble, using estimated costs of $86.50 per arc-rated faceshield [11] and $29.75 per arc-rated balaclava [12]. OSHA assumes that 80 percent of affected workers at small establishments and 90 percent of power workers at large establishments would need to wear this equipment under the NFPA approach, for total annualized costs of $8.3 million, or an additional annualized cost of approximately $7.1 million.

Under this more stringent alternative, the estimated total annualized cost of arc-hazard assessment and arc-flash protective equipment would be approximately $32.4 million, and the estimated total annualized cost of the rule would be approximately $62.5 million. Under the final rule, OSHA estimated the total annualized costs of arc-hazard assessment and arc-flash protective equipment to be approximately $19.4 million and estimated the total annualized cost of the rule to be approximately $49.5 million. As outlined in Table 18, the NFPA alternative would result in approximately $12.9 million in additional costs relative to the final rule.

TABLE 18—ALTERNATIVE REGULATORY APPROACHES

Provision	Annualized costs for provisions in final rule	Less stringent alternative	More stringent alternative
Calculating Incident Energy and Arc-Hazard Assessment (Arc-Hazard Assessment)	$2,186,883	$0	$0
Flame-Resistant Apparel	15,620,365	15,620,365	23,664,751
Switching Coats or Flash Suits	366,245	0	366,245
Faceshields	946,964	0	6,212,770
Head Protection	325,690	0	2,136,762
Total Arc-Hazard Assessment and Arc-Flash Protective Equipment Costs	19,446,147	15,620,365	32,380,528
Total Cost of Rule	49,516,264	45,690,483	62,450,646
Incremental Annualized Cost of Alternative	.....	−3,825,782	12,934,381
Incremental Lives Saved Annually of Alternative	.....	−0.52	0
Incremental Injuries Prevented Annually of Alternative	.....	−3	0
Incremental Monetized Benefits	.....	−4,710,000	0
Incremental Net Benefits ($)	.....	−884,218	−12,934,381

Note: Totals may not equal the sum of the components due to rounding.
Source: Office of Regulatory Analysis, OSHA.

[484] The term "power worker" describes workers affected by the rule by virtue of their performing electric power generation, transmission or distribution work.

[485] References are available at the end of this section of the preamble.

[486] Clothing rated at 8 cal/cm^2 would, in turn, offer more than adequate protection for incident heat energy of 8 cal/cm^2 or less.

[487] This FEA uses the term "flame-resistant clothing" to refer generally to the flame-resistant and arc-rated clothing, and the term "arc-flash protective equipment" to refer to the flame-resistant and arc-rated clothing and equipment, required by § 1926.960(g).

To assess the benefits associated with the alternative versions of the arc-flash protective equipment requirements, OSHA considered the fatalities prevented under the various approaches. A review of the same set of IMIS reports used in the benefits analysis described later (see the discussion under the heading "Benefits, Net Benefits, and Cost Effectiveness") indicates that the more stringent requirement would prevent an estimated 1.92 fatalities, while the less stringent option would prevent an estimated 1.40 fatalities per year. These options compare to an estimated 1.92 preventable fatalities under the provision in the final rule. Consistent with the benefits methodology described elsewhere in this section, the Agency estimates the final rule will prevent approximately an additional 0.52 fatalities and 3 injuries annually beyond the less stringent alternative, but would be as effective as the more stringent alternative, as the arc-hazard assessment allows employers to better target their need for protective clothing and equipment. Monetizing these prevented fatalities using the methodology described in the benefits analysis, and values of $8.7 million per prevented fatality and $62,000 per prevented injury, results in an estimated incremental monetized benefit of about $0.9 million per year for the final rule over the less stringent option and about $12.9 million a year over the more stringent option.

Profile of Affected Industries

The final rule affects establishments in a variety of different industries involving electric power generation, transmission, and distribution. The rule primarily affects firms that construct, operate, maintain, or repair electric power generation, transmission, or distribution systems. These firms include electric utilities, as well as contractors hired by utilities and primarily classified in the construction industry. In addition, affected firms appear in a variety of manufacturing and other industries that own or operate their own electric power generation, transmission, or distribution systems as a secondary part of their business operations. The rule also affects establishments performing line-clearance tree-trimming operations.

Some other industries will occasionally enter electric power facilities (for example, insurance inspectors (Ex. 0198)). OSHA expects that this rule will have no significant economic impact on industries such as the insurance industry that occasionally have employees enter electric power facilities for purposes other than construction or maintenance. Further, to the extent such visitors to electric power facilities are within the scope of the rule, the more costly provisions of the rule are unlikely to have a substantial effect on those visitors. (For a discussion of the application of the final rule to insurance inspections and the implications for costs for the insurance industry, see the summary and explanation for final § 1926.950(a)(1), in Section V, Summary and Explanation of the Final Rule, earlier in this preamble.) Finally, while final §§ 1910.137 and 1926.97 apply to all general industry work and all construction work, respectively, OSHA anticipates that these final rules will primarily impact industries involved in electric power generation, transmission, and distribution, and industries in the nonutility sector involved with the cogeneration of electric power. OSHA, therefore, concludes that these final rules will have a *de minimis* effect on other industries.

OSHA based the PRIA in part on a report prepared by CONSAD [5], which used 1997 NAICS and SIC code classifications of industries. OSHA updated the information in the FEA with the assistance of ERG, using the data sources described in the following paragraphs. CONSAD based the estimates it developed for small, large, and total establishments on the 1997 U.S. Economic Census, which used some NAICS classifications that are now obsolete. To be analytically consistent, however, OSHA is maintaining the older NAICS categories.

To update industry profile information for the construction industry (NAICS 23), OSHA used the U.S. Census' County Business Patterns data [47] on the growth of the construction contracting industry between 1997 and 2007. These data suggest that the number of establishments and firms grew 20.6 percent, and employment grew 32.7 percent, from 1997 to 2007. OSHA, thus, multiplied CONSAD's estimate of the number of establishments and affected establishments by 1.206, and CONSAD's estimate of total employment and affected power workers by 1.327, to obtain updated industry profile information. In the case of firms, CONSAD listed total affected firms for each NAICS, but did not delineate between small and large firms. To update the number of affected firms in the construction industry, OSHA multiplied CONSAD's estimate of total affected firms by 1.206, and assumed that, because very small firms (that is, those with fewer than 20 employees) are unlikely to have more than one establishment, the number of small firms is equal to the number of small establishments and that the remainder of affected firms are large. OSHA assumed that very small establishments and firms grew in proportion to the rest of the construction industry.

In the case of the privately owned utilities in the 1997 NAICS Electric Power Generation (NAICS 221110) and Electric Power Transmission, Control, and Distribution (NAICS 221120) categories, OSHA updated industry profile information using the U.S. Census Bureau's 1997 NAICS and 1987 SIC Correspondence Tables [44], 1997 NAICS to 2002 NAICS Correspondence Tables [45], and 2002 NAICS to 2007 NAICS Correspondence Tables [46] to match CONSAD's NAICS and SIC categories to the 2007 NAICS categories. The 1997 category Electric Power Generation (NAICS 221110) is the sum of the 2007 NAICS categories: Hydroelectric Power Generation; Fossil Fuel Electric Power Generation; Nuclear Electric Power Generation; and Other Electric Power Generation. Similarly, the 1997 NAICS category Electric Power Transmission, Control, and Distribution (NAICS 221120) is the sum of the 2007 NAICS categories: Electric Bulk Power Transmission and Control; and Electric Power Distribution.

To calculate the number of establishments among Industrial Power Generators, OSHA used data from the Energy Information Administration (EIA)'s Form EIA–860 Database Annual Electric Generator Report [49], removed plants primarily engaged in the utility, mining, or agriculture industries, and counted the remaining plants as establishments among industrial power generators.

To estimate the number of major publicly owned utilities for the analysis prepared for the proposed rule, CONSAD used EIA's Form-412 Annual Electricity Financial Report, which contained data on "each municipality, political subdivision, State, and Federal entity engaged in the generation, transmission, or distribution of electricity, which had at least 150,000 megawatt hours of sales to ultimate consumers and/or at least 150,000 megawatt hours of sales for resale for each of the 2 previous years" [48]. EIA terminated this survey, and there are no data more recent than 2003.

To update CONSAD's estimate of publicly owned utility establishments and firms, OSHA used data from EIA's Form-861 Annual Electric Power Industry Report [50] for utilities with municipal, state, or political subdivision ownership located in State-plan States

with sales of at least 150,000 megawatt-hours. These data indicate that there are now 277 firms that are major publicly owned utilities. Establishment data are not available for these utilities. In the analysis prepared for the proposed rule, OSHA estimated that there were 923 establishments and 276 firms, and OSHA used the same ratio of establishments to firms to estimate that there are now 927 establishments among firms that are Major Publicly Owned Utilities.

Similarly, there are no Census or EIA data on employees in Major Publicly Owned Utilities.[488] Applying the ratio of power workers to utilities in CONSAD's report [5], OSHA estimated employment in Major Publicly Owned Utilities (NAICS 2211) by taking the EIA Form-861 [50] establishment data and extrapolating from those data an estimate of 8,582 employees at Major Publicly Owned Utilities affected by the final rule.[489]

OSHA used several data sources to estimate the number of line-clearance tree trimmers (SOC 37–3013) affected by the rule within Ornamental Shrub and Tree Services (SIC 0783) (now included in NAICS 561730, Landscaping Services). To estimate the number of establishments performing line-clearance tree-trimming operations in NAICS 561730, Landscaping Services, OSHA used 2007 BLS Occupational Employment Statistics data [34] combined with establishment data from the 2007 BLS Quarterly Census of Employment and Wages [35]. These data suggest that there are 4,803 establishments in NAICS 561730 Landscaping Services that employ tree trimmers and pruners (SOC 37–3013). Based on statistics on the distribution of establishments by employment size for NAICS 561730 reported in the 2007 U.S. Census' Statistics of U.S. Businesses, OSHA estimated that 4,479 of these establishments have fewer than 20 employees or fewer and that 324 of these establishments have 20 employees or more [43].[490] In the analysis prepared for the proposed rule, CONSAD used data from the National Arborist Association[491] to estimate the number of establishments in SIC 0783 involved in line-clearance tree-trimming operations, with approximately 90 percent of large establishments (291 establishments) and 2 percent of small establishments (90 establishments) performing line-clearance tree-trimming operations. OSHA applies these same percentages of affected large and small establishments to the BLS data, which suggests that there are 381 affected establishments.

U.S. Census data [43] suggest that total employment in Landscaping Services (NAICS 561730) is 572,520, with 260,815 of these employees (46 percent)[492] working at establishments that employ fewer than 20 employees and 311,705 (54 percent) working at establishments that employ 20 employees or more. To estimate the proportion of employees in NAICS 561730 potentially affected by the proposed rule, OSHA used BLS data [38] suggesting that there are a total of 32,600 tree trimmers and pruners (SOC 37–3013) working in Landscaping Services (NAICS 561730). OSHA extrapolated the percentage of employees working at small and large establishments in all establishments in NAICS 561730 to establishments that employ tree trimmers and pruners, suggesting that there are 14,851 (46 percent of 32,600) employees at small establishments and 17,749 (54 percent of 32,600) at large establishments potentially affected by the final rule. OSHA then used CONSAD's determination of the proportion of these workers who are doing line-clearance tree-trimming work, suggesting that 5 percent of workers at small establishments (768 workers) and 81 percent of workers at large establishments (14,318 workers) perform line-clearance tree-trimming operations, for a total of 15,086 employees doing line-clearance tree-trimming work covered by the final rule.

Table 19 presents data on the numbers of affected establishments and employees for each affected industry. Across all industries, an estimated 24,407 establishments and 211,452 employees will be affected by the final rule.

TABLE 19—PROFILE OF AFFECTED ESTABLISHMENTS AND EMPLOYEES

Industry code	Industry name	Affected firms	Affected establishments	Affected employees
NAICS 234910	Water, Sewer, and Pipeline Construction	106	1,021	1,262
NAICS 234920	Power and Communication Transmission Line Construction	2,870	3,412	34,740
NAICS 234930	Industrial Nonbuilding Structure Construction	158	321	1,846
NAICS 234990	All Other Heavy Construction	28	791	7,395
NAICS 235310	Electrical Contractors	51	1,945	21,686
NAICS 235910	Structural Steel Erection Contractors	120	786	398
NAICS 235950	Building Equipment and Other Machine Installation Contractors	202	1,148	373
NAICS 235990	All Other Special Trade Contractors	313	3,150	974
NAICS 221110	Electric Power Generation	626	2,171	37,560
NAICS 221120	Electric Power Transmission, Control, and Distribution	1,232	7,440	64,179
NAICS 2211	Major Publicly Owned Utilities	277	927	8,582
Various	Industrial Power Generators	197	913	17,372

[488] The category "Major Publicly Owned Utilities" does not have its own NAICS code. In this analysis, OSHA used the NAICS code 2211, which encompasses both privately and publicly owned utilities, to refer to "Major Publicly Owned Utilities" only, as OSHA found it necessary to account for the costs to Major Publicly Owned Utilities separately from the costs to private utilities. Similarly, OSHA used NAICS 221110 and NAICS 221120 to refer to privately owned utilities only, even though those NAICS codes include privately and publicly owned utilities.

[489] The rule will affect Major Publicly Owned Utilities that operate in OSHA State-plan States. (State-plan States cover about half of total U.S. employment. They operate their own OSHA-approved occupational safety and health programs and must, under formal agreements with OSHA, impose OSHA-equivalent State regulatory requirements on public employers operating major publicly owned utilities within their jurisdictions.)

[490] BLS Occupational Employment Statistics data [34] indicated that 5 percent of establishments in NAICS 561730 employ Tree Trimmers, and BLS Quarterly Census of Employment and Wages [35] data indicated that there were 96,605 establishments in NAICS 561730, suggesting that 4,803 establishments in NAICS 561730 employ tree trimmers. The portion of establishments with fewer than 20 employees was estimated based on the distribution of establishment sizes in NAICS 561730 as a whole, as reported in the 2007 U.S. Census's Statistics of U.S. Businesses [43].

[491] The National Arborist Association subsequently changed its name to the National Tree Care Industry Association.

[492] In this paragraph, as elsewhere in this section of the preamble, OSHA is presenting ratios in a concise, but rounded, format. For instance, the 46 percent cited is more precise in CONSAD's analysis, in this case 45.5556138 percent. This latter ratio is the precise ratio of numbers in the CONSAD analysis. OSHA used the more precise numbers in the calculations presented in this FEA.

TABLE 19—PROFILE OF AFFECTED ESTABLISHMENTS AND EMPLOYEES—Continued

Industry code	Industry name	Affected firms	Affected establishments	Affected employees
SIC 0783	Ornamental Shrub and Tree Services	309	381	15,086
Total		6,488	24,407	211,452

Note: Totals may not equal the sum of the components due to rounding.
Sources: CONSAD [5], EIA [49, 50], U.S. Census [43].

As shown in Table 19, the construction industries with the largest numbers of affected employees are the Power and Communication Transmission Line Construction and Electrical Contractors industries, which together account for 56,426 employees of the affected workforce. Other affected construction industries include All Other Heavy Construction, Building Equipment and Other Machine Installation Contractors, Industrial Nonbuilding Structure Construction, Structural Steel Erection Contractors, Water, Sewer, and Pipeline Construction, and All Other Special Trade Contractors.

Table 19 also shows that establishments classified as utilities (namely establishments in the Electric Power Generation industry (NAICS 221110) and the Electric Power Transmission, Control, and Distribution industry (NAICS 221120)) account for 9,611 of the potentially affected establishments and for 101,739 of the potentially affected employees. One commenter questioned whether OSHA distinguished between electric power generation and electric power transmission and distribution (Ex. 0227). OSHA included establishments classified in the Electric Power Generation industry (NAICS 221110) and in the Electric Power Transmission, Control, and Distribution industry (NAICS 221120), and the Agency distinguished between them in the industrial profile and in the costs and economic analysis.

Table 19 also shows OSHA's estimates of two special categories of electric generators not covered in the data sources used for Census on electric utilities: Major Publicly Owned Utilities and Industrial Power Generators. Table 19 shows that that there are 927 establishments with 8,582 employees for Major Publicly Owned Utilities. Firms in the Industrial Power Generator category include manufacturing and other industries that own or operate their own electric power generation, transmission, or distribution systems as a secondary part of their business operations. These firms account for 913 establishments and 17,372 employees. Based on their primary business activity, OSHA classified these establishments in the following industry sectors: Oil and Gas Extraction; Mining; Water, Sewer, and Other Systems; Food Manufacturing; Wood Product Manufacturing; Paper Manufacturing; Petroleum and Coal Products Manufacturing; Chemical Manufacturing; Primary Metal Manufacturing; Wholesale Trade, Durable Goods; Educational Services; and Hospitals.

Finally, Table 19 presents figures for the numbers of affected establishments and employees in the Ornamental Shrub and Tree Services industry. As noted previously, OSHA estimates that the final rule potentially affects 381 establishments and 15,086 employees in this industry. (Note that Table 19 does not present Census data for all employees and establishments in the Ornamental Shrub and Tree Services industry, but rather only employees and establishments estimated to perform line-clearance tree-trimming operations. For more detail, see the explanation of OSHA's estimates of employees and establishments in that industry earlier in this section of the preamble.)

E. Benefits, Net Benefits, and Cost Effectiveness

OSHA expects the final rule addressing electric power generation, transmission, and distribution work to result in an increased degree of safety for affected employees and to reduce the numbers of accidents, fatalities, and injuries associated with the relevant tasks. The accidents, fatalities, and injuries that the final rule will prevent include falls, some burns, and many electric-shock incidents. OSHA also expects the final rule to reduce the severity of certain injuries that the final rule will not prevent, but that could still occur during the performance of some of the affected work procedures. These injuries include, among others, injuries that could occur as a result of an arrested fall and some burns (for example, burns that result from employee exposure to incident energy from an electric arc greater than the employer's estimate).

To develop estimates of the benefits associated with the proposed rule, CONSAD researched and reviewed potential sources of useful data. CONSAD, in consultation with the Agency, determined that the most reliable data sources for this purpose were reports from OSHA fatality-catastrophe accident inspections contained in OSHA's IMIS, and the Census of Fatal Occupational Injuries (CFOI) developed by the Bureau of Labor Statistics.

From the IMIS and CFOI data, CONSAD identified and analyzed injuries and fatalities for the proposed rule. CONSAD based this analysis on over 9 years of data contained in these databases. CONSAD identified relevant cases in the databases by determining the criteria provided in the databases that would apply to such cases, such as the type of the injury, the occupation of the employee, the source of the injury, and the industry classification of the employer. CONSAD then reviewed individual accident abstracts to make a final determination whether to include the accident as one addressed by the proposed rule. The final report CONSAD submitted to OSHA includes a complete description of the methodological approach CONSAD used for analyzing the data [5].

CONSAD's analysis found that, on average, the IMIS and CFOI databases recorded 74 fatalities and 25 injuries annually involving circumstances directly addressed by the existing or proposed standards [5]. These figures likely represent underestimates of the injuries addressed by this rulemaking since the figures are cases documented by IMIS and CFOI only. As explained later under this heading of the FEA, OSHA adjusted the approach used in CONSAD's analysis to reflect a more accurate estimate of the number of total injuries affected by this rulemaking.[493]

The number of injuries addressed by this rulemaking is almost certainly much greater than the number included

[493] The number of fatalities addressed by this rulemaking also may be somewhat higher, but OSHA does not currently have a basis for estimating possible fatalities not included in the relevant data sources.

in CONSAD's analysis. Generally, the IMIS database includes injuries only when the incident in question involves at least one fatality or three or more hospitalizations. However, some individual States having OSHA-approved safety and health plans (for example, California) have more stringent reporting requirements than Federal OSHA, thereby assuring that the IMIS database included at least some single-injury cases (76 FR 36419). For this reason, CONSAD performed an analysis of the IMIS fatality and injury data from California, which requires employers to report all injuries involving hospitalization [6]. This analysis, which includes only injuries that involve hospitalization, found that the ratio of injuries to fatalities was over six to one.[494]

Applying this ratio to the number of known fatalities addressed by this rulemaking, OSHA estimated that 444 relevant serious injuries occur annually. Note that even this figure is probably low given that the applied ratio, which OSHA based on California data, did not account for injuries that did not involve hospitalization of a worker. Thus, OSHA estimates that 74 fatalities and 444 serious injuries occur annually among employees involved in electric power generation, transmission, and distribution work addressed by the provisions of this rulemaking.

To determine whether there were any significant declines in fatalities since the time period of the CONSAD analysis, OSHA examined available BLS CFOI data for the years 1992 to 2011 involving the electric power, transmission, and distribution industry, which includes all private-sector electric utilities. OSHA found that the number of fatalities per year on average was 10 percent lower than for the time period covered by the original CONSAD analysis. Most of the difference between the two time periods was due to a single anomalous year (2009) that had 55 percent fewer fatalities than any other year on record [8]. Based on these data, OSHA believes its earlier estimate of the numbers of fatalities and injuries associated with work addressed by this rulemaking continues to be accurate for purposes of estimating the magnitude of benefits expected as a result of the final rule.[495]

To determine how many of the 74 fatalities and 444 serious injuries the final rule would prevent, OSHA relied on CONSAD's probability estimates, based on expert judgment, that the existing rule or the proposed rule would prevent a given accident and the new rule would prevent that same accident. CONSAD estimated the probability of prevention on a case-by-case basis, and, therefore, did not find that the final rule would prevent all 74 fatalities and 444 serious injuries. To the contrary, CONSAD's estimate of the probability of prevention for individual accidents ranged from 5 percent to 95 percent [5]. Based on its review of CONSAD's analysis, OSHA estimates that full compliance with the existing standards would prevent 52.9 percent of the relevant injuries and fatalities. In comparison, full compliance with the final rule is estimated to prevent 79 percent of the relevant injuries and fatalities. Thus, the increase in safety provided by the final rule would prevent an additional 19.75 fatalities and 118.5 serious injuries annually. Applying an average monetary value of $62,000 per prevented injury and a value of $8.7 million per prevented fatality (as explained later under the "Benefits" heading of the FEA), OSHA estimates a monetized benefit of $179.2 million per year.

A number of commenters addressed these estimates. For example, EEI submitted a posthearing brief suggesting that the IMIS descriptions on which OSHA relied were not sufficiently reliable or detailed (Ex. 0501). EEI suggested as an alternative using the citations and investigative files generated by compliance officers in OSHA's field offices.

As EEI notes, reports generated by compliance officers serve as the basis of the IMIS data. Other advantages of the IMIS data are that OSHA reviews the data to ensure employee privacy, and the data are readily available to the public. As stated earlier, OSHA also accounted for uncertainties in the IMIS data by estimating the probability of prevention for each accident and did not assume that the existing or final rule was certain to prevent any accident. While the IMIS reports may be incomplete in that OSHA compliance officers investigate only accidents resulting in fatalities or multiple hospitalizations, OSHA believes IMIS reports are one of the best available sources for assessing the types and causes of serious accidents. OSHA used IMIS data for benefit assessments in a number of previous economic analyses, including the original benefits analysis for the existing general industry standard for Electric Power Generation, Transmission, and Distribution (§ 1910.269), which OSHA promulgated in 1994.[496]

EEI also suggested that OSHA should separately determine benefits for each individual hazard affected by this rulemaking (Ex. 0227).

In response, OSHA added for this FEA some analysis of the benefits associated with reducing burn injuries under the final rule (see the discussion under this heading of the FEA). However, OSHA did not rely on a further hazard-by-hazard analysis in computing benefits for its main analysis. Fundamentally, most of the fatalities and injuries prevented by the final rule relate to the single hazard of electric shock, and the final rule uses a variety of provisions, some redundant, to prevent those fatalities and injuries. Redundancy is a fundamental principle of safety systems—safety professionals do not rely on a single mechanism to prevent fatalities, but instead use more than one method to assure that the failure of a single mechanism does not lead to harm. As a result, OSHA cannot separately estimate the number of injuries or fatalities prevented by each of the specific provisions that, taken together, address the same basic hazard. A hypothetical example may clarify this point. Suppose we know with certainty that the addition of a training provision alone will reduce fatalities by 20 percent. Suppose that we also know that the addition of a host-contractor provision alone will reduce fatalities by

[494] OSHA relied on the IMIS data for California, and not the IMIS data for any other State, because, for the period covered by the IMIS data on which OSHA based its benefits determination, those data included reasonably complete hospitalization information only from California.

[495] The Agency also emphasizes that, except for firms coming into compliance with provisions of the final standard in advance of its promulgation, the passage of time should not affect significantly the relevant pattern of fatalities and injuries underlying the data. To the extent that higher rates of prepromulgation compliance than estimated in the FEA occurred, the expected benefits of the standard may be lower, but so would the costs of compliance and economic impact.

[496] To further support its argument that reliance on the IMIS data was improper, EEI questioned whether CONSAD "appreciate[d] and consider[ed] the distinction between the power generation, and power transmission and distribution, industries" (Ex. 0227). Thus, EEI criticized CONSAD's "review [of] the IMIS accident database for the time period January 1994 through April 2000, to ascertain the extent to which these power generation, transmission, and distribution accidents would have been preventable under the existing power generation, transmission, and distribution standards, and if the proposed revisions to these standards were implemented" (*id.*, internal citation omitted). EEI's assertion is baseless. In the final rule, OSHA properly relied on the IMIS data, which reveals that the injuries and fatalities suffered by workers performing power generation, transmission, and distribution work result from electric shocks, burns from electric arcs, and falls, as well as other types of harmful accidents, including accidents involving employees struck by, struck against, and caught between objects. OSHA also properly relied on the IMIS data to form its conclusion regarding the net benefits of complying with the final rule.

20 percent. It is perfectly possible that the addition of both provisions will reduce fatalities by 30 percent (rather than 40 percent) because host-contractor communications, in part, reduce the need for training and, likewise, training somewhat reduces the need for host-contractor communications. However, in this situation, there is no correct answer as to the extent to which each provision independently reduces fatalities because the two provisions are partially redundant and overlapping. In any event, this kind of hypothetical knowledge about the separate effects of each provision in a rule is rarely, if ever, available. In light of these limitations, OSHA typically estimates the joint effects of all of the provisions (that is, the benefits of the final rule in its entirety). See Section II.D, Significant Risk and Reduction in Risk, earlier in this preamble, for additional discussion.

Despite these impediments to a provision-by-provision benefits analysis, in an effort to ensure the transparency of its analysis, OSHA reviewed and reanalyzed each IMIS accident from 1995 and later from the CONSAD report [5] and, based on those results, provided a supplemental "Break-Even Sensitivity Analysis, Including Provision-by-Provision Analysis of Benefits," in an appendix under this heading of the FEA. OSHA undertook this additional analysis for two reasons: (1) It adds a provision-by-provision analysis to the calculation of the rule's aggregate probability of accident prevention, enabling OSHA to tie analysis of the accidents more closely to individual provisions or groups of provisions; and (2) it enables OSHA to calculate the percentages of accidents that need to be prevented to assure that a given provision, or combination of provisions, will pay for itself, or themselves, and to then discuss the likelihood of achieving that level of prevention.

OSHA presents the results of the supplemental analysis in detail in the appendix. In short, the break-even level of accident prevention needed for the benefits to exceed costs for various provisions ranged between 0.8 percent for minimum approach distances and 18.5 percent for arc-flash protection. With an accounting for joint prevention by multiple provisions, the break-even analysis results ranged between 2.3 percent for aerial lift fall protection and 23.8 percent for arc-flash protection. OSHA concludes in the appendix that the benefits of this rule's provisions will exceed these break-even levels. For instance, if there is full compliance with the combination of provisions intended to protect against arc-flash related accidents, then there should be no fatalities and very few or no serious injuries involving arc flash.

However, OSHA did not rely on the supplemental analysis to meet any OSH Act legal test for the final rule or to determine costs and benefits of the final rule. As discussed in Section IV, Legal Authority, earlier in this preamble, OSHA must demonstrate that a safety or health standard substantially reduces a significant risk of material harm in the workplace (see *Lockout/Tagout II*, 37 F.3d 665, 668–69 (D.C. Cir. 1994)), and the supplemental analysis cannot serve this purpose. As explained earlier in this preamble (Section II.D, Significant Risk and Reduction in Risk), OSHA concluded that the final rule will substantially reduce significant risk based on the 19.75 fatalities and 118.5 serious injuries that this FEA demonstrates the final rule will prevent each year, a conclusion OSHA cannot draw from the supplemental analysis. Accordingly, the supplemental analysis focuses on the percentage of potential benefits individual provisions must achieve for the benefits of those provisions to break even with the costs of those provisions.

EEI also asserted that an individual accident case CONSAD reviewed did not clearly establish the benefits of the final standard (Exs. 0227, 0501). EEI maintained that CONSAD's judgment in the review of this case was unreliable (*id.*).

Reviewing cases will inevitably involve professional judgment based on limited information, with the results described reasonably only in probabilistic terms. The Agency stands by that professional judgment with respect to this accident. Moreover, EEI's narrow focus on an individual accident is misplaced. OSHA's professional judgment, as a whole, provides a substantial body of evidence to support the standard. The Agency's analysis recognizes that full compliance with the existing standard would prevent a number of fatalities and injuries. Nonetheless, the Agency believes that a close reading of the accident abstracts, as embodied in its final analysis, indicates that the final standard will prevent about half of the remaining cases. Therefore, the Agency believes its approach represents the use of the best available techniques applied to the best available data. (See Tr. 83–84.)

OSHA also believes, based on its supplemental analysis of benefits (see the appendix under this heading of the FEA), that its main analysis represents a low estimate of benefits. In this regard, the supplemental analysis found that fatalities and serious injuries from climbing-fall-protection, minimum approach-distance, and arc-flash-related accidents are virtually impossible if there is full compliance with the final rule, and that, if there is full compliance, the final rule will prevent 40.8 of the 74 annual fatalities, and 245.1 of the 444 annual serious injuries, addressed by the final rule (see Table 7 in supplemental analysis). As such, OSHA interprets the supplemental analysis as indicating that OSHA's estimate is conservative, based on the CONSAD analysis, that this final rule will prevent 19.75 of the 74 annual fatalities, and 118.5 of the 444 annual serious injuries, addressed by the final rule.

One commenter stated that, in the proposal, OSHA relied on data from 1991 to 1998, and that this data was inadequate to show the benefits associated with the promulgation of § 1910.269 in 1994 (Ex. 0180).

The premise of the comment is incorrect. The underlying CONSAD analysis of data covers the period from 1984 to 2001, and, therefore, provides nearly 7 years of post-1994 experience (not 3 years, as asserted by the commenter).

One commenter, Frank Brockman of the Farmers Rural Electric Cooperative Corporation, asserted that, from experience, only a small number of fatalities arose from situations that did not represent violations of existing rules (Ex. 0173).

In response to Mr. Brockman's comments, OSHA first notes that its analysis draws from a nationwide pool of data that will likely exceed any individual's personal experience. Second, although most of the existing cases are preventable by full compliance with existing standards, as explained more fully in the supplemental analysis, there remain a number of accidents unaffected by existing standards that the final rule will affect; and, even though full compliance with existing standards might prevent an accident, new requirements in the final rule, like the information-transfer and job-briefing provisions, will make it easier to assure full compliance with existing standards.

Another commenter suggested that OSHA's estimate in the PRIA was likely an overestimate of the benefits because the Agency assumes full compliance:

> The estimated prevention of 19 fatalities and 116 injuries is a likely overstatement of benefits of this rulemaking because it based on an estimate of full compliance with the new regulation. 70 Fed. Reg. 34894. Clearly from the description provided of the actual record of fatalities and injuries, failure of compliance with the current rule is the primary reason lives were endangered. A

more candid analysis would estimate the compliance rate as a part of the calculation, which is likely 50 percent to 95 percent if OSHA's analysis of training compliance was used. [Ex. 0240]

In response to this comment OSHA concludes, based on its analysis, that compliance with the final standard, as a whole, will reduce fatalities and injuries to a greater extent than compliance with the existing standard, as a whole. Moreover, when performing an analysis of the economic feasibility of a standard, it is necessary to assume full compliance with the standard. Otherwise, the Agency could always find a standard economically feasible by assuming that employers for whom it was not feasible would not comply with the standard.

To estimate the monetary value of preventing a fatality, OSHA followed the Office of Management and Budget's (OMB) recommendation (OMB Circular A–4, [30]) to rely on estimates developed using a methodology based on the willingness of affected individuals to pay to avoid a marginal increase in the risk of a fatality.

To develop an estimate using the willingness-to-pay approach, OSHA relied on existing studies of the imputed value of fatalities avoided based on the theory of compensating wage differentials in the labor market. These studies rely on certain critical assumptions for their accuracy, particularly that workers understand the risks to which they are exposed, and that workers have legitimate choices between high-risk and low-risk jobs. These assumptions are rarely accurate in actual labor markets. A number of academic studies, summarized in Viscusi and Aldy [53], show a correlation between job risk and wages, suggesting that employees demand monetary compensation in return for a greater risk of injury or fatality. The estimated tradeoff between lower wages and marginal reductions in fatal occupational risk—that is, workers' willingness to pay for marginal reductions in such risk—yields an imputed value of an avoided fatality: the willingness-to-pay amount for a reduction in risk divided by the reduction in risk. OSHA used this approach in many recent proposed and final rules. (See, for example, 69 FR 59306 (Oct. 4, 2004) and 71 FR 10100 (Feb. 28, 2006), the preambles for the proposed and final Hexavalent Chromium rules.) [497]

OSHA reviewed the available research literature on willingness to pay. Viscusi and Aldy conducted a metaanalysis of studies in the economics literature that used a willingness-to-pay methodology to estimate the imputed value of life-saving programs, and concluded that each fatality avoided should have a value of approximately $7 million in 2000 dollars [53]. Using the U.S. Bureau of Economic Analysis' Gross Domestic Product Deflator [31], this $7 million base number in 2000 dollars yields an estimate of $8.7 million in 2009 dollars for each fatality avoided. This Value of a Statistical Life estimate also is within the range of the substantial majority of such estimates in the literature ($1 million to $10 million per statistical life, as discussed in OMB Circular A–4 [30]).

Workers also place an implicit value on nonfatal occupational injuries or illnesses avoided. This value reflects a worker's willingness to pay to avoid monetary costs (for medical expenses and lost wages) and quality-of-life losses. Viscusi and Aldy found that most studies had estimates in the range of $20,000 to $70,000 per injury, and several studies had even higher values [53]. The measure of nonfatal job risks used partly explains the range of values: some studies use an overall injury rate, and other studies use only injuries resulting in lost workdays. The injuries prevented by this final rule generally will be hospitalized injuries, which are likely to be more severe, on average, than other lost-workday injuries. In addition, this final rule will reduce the incidence of burn injuries, which tend to be severe injuries, involving more pain and suffering, more expensive treatments, and generally longer recovery periods than other lost-workday injuries. Thus, for this rulemaking, OSHA believes it is reasonable to select an estimated value of a statistical injury in the upper part of the reported range of estimates. OSHA, accordingly, uses a base number of $50,000 in 2000 dollars. Updating this estimate using the Gross Domestic Product deflator [31], OSHA estimates a value of $62,000 per prevented injury.

Frank Brockman of the Farmers Rural Electric Cooperative Corporation commented that OSHA has "vastly overestimated" the valuation of fatalities, citing the National Safety Council's (NSC) valuation of $1 million per fatality [26], which he claimed was a more "realistic" estimate of the "cost" of a fatality (Ex. 0173). The commenter did, however, suggest a substantially larger estimate of the cost of injury, $250,000, as perhaps being more typical of the electric power industry.

The Agency notes that the concept of valuation of benefits in question is fundamentally different than a simple loss of wages and medical costs, or what is sometimes referred to as the "direct cost" approach. As stated on the NSC Web site after introducing their $1 million (updated to $1.29 million for 2009 dollars) figure:

> [This estimate] should not be used, however, in computing the dollar value of future benefits due to traffic safety measures because they do not include the value of a person's natural desire to live longer or to protect the quality of one's life. That is, the economic loss estimates do not include what people are willing to pay for improved safety. Work has been done to create the necessary theoretical groundwork and empirical valuation of injury costs under the "willingness to pay" or comprehensive cost concept. [26]

The NSC's statement validates the Agency's decision to use the willingness-to-pay approach in valuing benefits.

Finally, OSHA notes that although the Agency lacks a complete body of data specific to the electric power industry that reflects the economic loss involved in the types of injuries these workers will frequently encounter, its estimate of the value of preventing an injury may well be understated. As Dr. Mary Capelli-Schellpfeffer testified at the hearings:

> Then this figure, Figure 4, takes us to an illustration of a real patient case, where the worker was in a 600 volt scenario, in a power generation facility, and this is the human consequence—not the staged consequence, but the human consequence—of being in an electric shock and electric arc event, where the injuries are severe.
>
> * * * * *
>
> So in Figure 4 the extent of the injury that can follow an arc exposure is readily appreciated. Eyes, ears, faces, skin, limbs, and organs are affected. Basic bodily function, including the ability to breathe, eat, urinate, and sleep are completely changed.
>
> For this patient initial medical treatment costs more than $650,000 including five surgeries; $250,000 for reconstructive surgeries as an outpatient; and subsequent

[497] The Agency used the willingness-to-pay approach in the PRIA for this rule as well. In estimating the value of preventing a fatality in the PRIA, OSHA relied on an estimate by EPA, which made an earlier attempt to summarize the willingness-to-pay literature (70 FR 34901). For the FEA, the Agency went directly to the underlying literature, a recent summary by Viscusi and Aldy [53], to update its valuation. The estimate in the PRIA equaled $6.8 million per fatality prevented in 2003 dollars; this amount would, in turn, equal $7.9 million in 2009 dollars. The difference between the underlying valuation used in the PRIA and the underlying valuation used in this FEA is not significant for the purposes of OSHA's analysis of the final rule. In the PRIA, OSHA used Viscusi and Aldy [53] for valuing injuries, but not for valuing fatalities. For this FEA, OSHA used recent Viscusi and Aldy [53] for valuing both injuries and fatalities because Viscusi and Aldy is more recent than the EPA estimated used in the PRIA.

admissions and $250,000 for five years of rehabilitation, including over 100 physician visits and numerous therapy sessions.

These costs represent only direct medical expenditures, without inclusion of indirect employer and family costs. [Tr. 185–186 [498]]

OSHA estimates the net monetized benefits of the final rule at $129.7 million annually ($179.2 million in benefits minus $49.5 million in costs). These net benefits exclude any unquantified benefits associated with revising existing standards to provide updated, clear, and consistent regulatory requirements. Given that monetized benefits are nearly four times larger than the estimated costs of the standard, the total estimated benefits of the standard could be approximately four times smaller than OSHA's estimate, and the rule would still retain positive net monetized benefits. Thus, benefits would exceed costs even if the new rule prevented no more than 5.5 fatalities and 29.6 serious injuries per year. This number is significantly less than the 19.75 fatalities and 118.5 serious injuries that OSHA estimates the final rule will prevent. Further, as explained earlier, the supplemental analysis suggests that there are far more than 19.75 fatalities and 118.5 serious injuries that this final rule will prevent. Finally, for reasons discussed in the supplemental analysis, full compliance with the existing rule will not prevent certain accidents the final rule will prevent, and although compliance with the existing rule might prevent some accidents, full compliance with the final rule will make it more likely that employers will comply with the existing rule. As a result, OSHA is confident that benefits of the final rule exceed the costs.

Table 20 and Table 21 provide an overview of the estimated benefits associated with this final rule. Table 22 shows costs and benefits of the final rule, in 2009 dollars, for the first 10 years after the rule becomes effective.

TABLE 20—NET BENEFITS AND COST EFFECTIVENESS

Annualized costs:	7 Percent	3 Percent
Calculating Incident Energy and Arc-Hazard Assessment (Arc-Hazard Assessment).	$2.2 million	$1.8 million.
Provision of Arc-Flash Protective Equipment	17.3 million	15.7 million.
Fall Protection	0.6 million	0.4 million.
Host-Contractor Communications	17.8 million	17.8 million.
Expanded Job Briefings	6.7 million	6.7 million.
Additional Training	3.0 million	2.7 million.
Other Costs for Employees not Already Covered by § 1910.269	0.2 million	0.2 million.
MAD Costs	1.8 million	1.8 million.
Total Annual Costs	49.5 million	47.1 million.
Annual Benefits:		
Number of Injuries Prevented	118.5	118.5.
Number of Fatalities Prevented	19.75	19.75.
Monetized Benefits (Assuming $62,000 per Injury and $8.7 Million per Fatality Prevented.	179.2 million	179.2 million.
OSHA Standards that Are Updated and Consistent	Unquantified	Unquantified.
Total Annual Benefits	118.5 injuries and 19.75 fatalities prevented.	118.5 injuries and 19.75 fatalities prevented.
Net Benefits (Benefits minus Costs):	129.7 million	132.0 million.
	Compliance with the final rule will result in the prevention of one fatality and 6 injuries per $2.5 million in costs, or, alternatively, $3.62 of benefits per dollar of costs.	

Note: Totals may not equal the sum of the components due to rounding.
Sources: Provided in text.

TABLE 21—OVERVIEW OF ANNUAL BENEFITS

	Injuries	Fatalities
Total Addressed by the Final Rule	444	74.
Preventable through Full Compliance with Existing Standards (52.9 percent)	235	39.
Additional Preventable with Full Compliance with Final Rule (26.1 percent)	118.5	19.75.
Monetized Benefits (Assuming $62,000 per Injury and $8.7 million per Fatality Prevented)	$7.3 million	$171.8 million.
Total Monetized Benefits	$179.2 million.	

Notes: (1) Totals may not equal the sum of the components due to rounding.
(2) Additional benefits associated with this rulemaking involve providing OSHA standards that are updated, clear, and consistent.
Source: CONSAD [5].

[498] OSHA concludes that it conservatively underestimated benefits using its willingness-to-pay valuation of $62,000 per injury. First, a study of burn injuries (Ex. 0424) indicated that, between 1991 and 1993, the average medical cost for burns was $39,533. Adjusting for inflation (to 2009 dollars) using the Medical Services Consumer Price Index raises this cost to $76,694. Second, OSHA calculated an alternative willingness-to-pay valuation using a sensitivity analysis that assumed that 25 percent of burn injuries were sufficiently severe as to equal 58.3 percent of a statistical value of a life for a severe nonfatal medical event [22]. If OSHA used this alternative formulation, the total benefits of the rule would increase from $179 million to $328 million.

TABLE 22—COSTS AND BENEFITS OVER TIME

[Millions of 2009$]

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Total Costs*	$107.9	$20.3	$22.6	$20.3	$75.5	$22.6	$22.6	$20.3	$75.5	$20.3
Monetized Benefits†	179.2	179.2	179.2	179.2	179.2	179.2	179.2	179.2	179.2	179.2

*Costs after the first year will vary as a result of the estimated cycle of protective equipment replacement: 2 years for faceshields and balaclavas, 4 years for flame resistant apparel, and 5 years for body harnesses and positioning straps.

†Assuming $62,000 per injury and $8.7 million per fatality prevented.

Additional benefits associated with this rule involve providing updated, clear, and consistent safety standards regarding electric power generation, transmission, and distribution work to relevant employers, employees, and interested members of the public. The existing OSHA standards for the construction of electric power transmission and distribution systems (Subpart V) are over 30 years old and inconsistent with the more recently promulgated standard addressing repair and maintenance work in § 1910.269. OSHA believes that the updated standards are easier to understand and to apply than the existing standards and will improve employee safety by facilitating compliance.

As explained earlier, inconsistencies between Subpart V and § 1910.269 can create numerous difficulties for employers and employees. The benefits associated with providing updated, clear, and consistent safety standards are likely substantial, but OSHA did not monetize or quantify them.

The Small Business Advocacy Review Panel (which OSHA convened for this rulemaking in accordance with the provisions of the Small Business Regulatory Enforcement Fairness Act of 1996 (Pub. L. 104–121), as codified at 5 U.S.C. 601 *et seq.*) (Ex. 0019 [29]) and others (see, for example, Ex. 0227) expressed concern about the balance of risk and costs in employing protective equipment to prevent arc-related burns.

In response to this concern, the Agency performed an analysis of burn injuries in the electric power and distribution industry to specifically estimate the effect of the final rule on preventing burns from electric arcs or on reducing the severity of any arc-related injuries sustained by workers. To assess the effectiveness of the final rule in preventing fatalities associated with burns from exposure to electric arc-related accidents, OSHA reviewed IMIS accident reports already in the record for the period January 1991 through December 1998 (Ex. 0004).[499] OSHA identified 99 accidents that involved burns from arcs from energized equipment faults or failures, resulting in 21 fatalities and 94 hospitalized injuries [8]. Based on this data, OSHA estimates that an average of at least 8 burn accidents occur each year involving employees doing work covered by this final rule, leading to 12 nonfatal injuries and 2 fatalities per year (*id.*). Of the reports indicating the extent of the burn injury, 75 percent reported third-degree burns (*id.*). Proper protective equipment and clothing would reduce the number of fatalities and the severity of these injuries.

Based on the description of the accidents contained in the IMIS reports, OSHA determined that the IMIS reports indicate that compliance with the final rule would prevent 11 of the 21 fatalities either by averting the injury altogether (2 cases) or by reducing the severity of nonfatal injuries (9 cases). The IMIS accident reports, therefore, indicate that the final rule will prevent 1.14 burn-related fatalities a year.[500]

A comparison of the total number of IMIS fatal accidents covered by the final rule and the number of comparable fatalities reported in the BLS CFOI data suggests that IMIS undercounts fatality numbers related to electric power generation by about 41 percent [5, 8]. Increasing the number of preventable fatalities by this factor (1.00/(1.00–0.41) = 1.69) results in an estimate of 1.92 burn fatalities per year averted under the final rule (1.14 IMIS burn fatalities × 1.69) [8]. This estimate is somewhat higher than the estimate of 1.57 burn fatalities estimated for the proposal.[501]

OSHA determined that the final rule would prevent 36.2 percent of nonfatal burn injuries such as the nonfatal burn injuries identified in the IMIS data, compared to 17.0 percent prevented under the proposed rule. OSHA's review of the IMIS data also found that 75 percent of burn accidents resulted in third-degree burns to one or more of the victims [8]. The Agency believes that the societal costs, including substantial treatment costs and significantly reduced quality of life, for severe burns is closer to the value of a prevented fatality than to the value generally assigned to prevented injuries (Tr. 185–186).

Requiring the use of body harnesses instead of body belts as fall arrest equipment for employees working from aerial lifts, in conjunction with other provisions of the final rule, such as the information-transfer, job-briefing, and training provisions, would likely reduce fatalities and injuries among affected workers. There are several problems with body belts. First, they are more likely than harnesses to result in serious injury during a fall because body belts place greater stress on the workers' body. Second, body belts virtually eliminate the possibility of self rescue after the fall, and increase the probability of serious internal injuries as the worker hangs suspended after the arrested fall. Studies performed in Europe and by the U.S. Air Force indicate high risks associated with the body belt as used both in fall-arrest and suspension modes. Third, it is difficult for supervisors to determine visually if workers are using body belts as fall arrest equipment. By contrast,

[499] As previously indicated, the Agency reviewed more recent BLS CFOI data to verify the continued relevance of the IMIS data on which OSHA relied in the proposed and final rules.

[500] OSHA made an error in calculating the number of prevented fatalities per year. The actual number of fatalities prevented each year is 1.38, or the number of prevented fatalities (11) divided by the number of years covered by the data (8). A similar error affects the estimated number of injuries prevented annually described later in this section of the FEA. Because the annual estimate of 1.14 prevented fatalities, and the corresponding estimate of prevented burn injuries, are conservative, OSHA elected to base its benefits, in part, on those values rather than the actual values.

[501] Based on the increase in the estimated number of burn fatalities prevented, the Agency determined that, on an average annual basis, the final rule will prevent an additional 0.35 fatal cases beyond the fatal cases OSHA estimated in the proposal. The CONSAD analysis previously estimated 19.4 cases prevented annually [5]. Hence, the Agency's estimate for the final rule is 19.75 fatalities prevented annually. By extension, the Agency estimates that the final rule will prevent 118.5 injuries annually, or 2.5 more injuries annually than OSHA estimated in the proposal. OSHA notes, however, that its revised estimate for the final rule does not account for other types of fatalities and injuries (that is, electric shock or falls) prevented by the new requirements of the final rule not contained in the proposal (that is, new minimum approach-distance and fall protection requirements). For this reason (as well as for other reasons contained in this FEA), OSHA's estimate is likely to be conservative.

supervisors can easily see from a distance whether a worker is wearing a harness. Finally, there is a greater risk that a worker could slip out of a body belt than a harness. As a result of these considerations, many employers already switched to requiring harnesses rather than body belts. Studies documenting the inappropriateness of, and the safety risks associated with the use of, body belts as part of a fall arrest system include Document IDs OSHA–S206–2006–0699–0039, OSHA–S206–2006–0699–0171, OSHA–S206–2006–0699–0173, OSHA–S206–2006–0699–0174, and OSHA–S206–2006–0699–0177 in Docket OSHA–S206–2006–0699 [502] and Document IDs OSHA–S700A–2006–0723–0044, OSHA–S700A–2006–0723–0065, OSHA–S700A–2006–0723–0066, OSHA–S700A–2006–0723–0067, and OSHA–S700A–2006–0723–0068 in Docket OSHA–S700A–2006–0723.[503]

An average of about 15 fatalities annually involve falls from aerial lifts; in these cases, the employees typically were not wearing a belt or a harness. Since most employees wear a belt or a harness (according to the CONSAD report, the current compliance rate is over 80 percent), there are likely to be at least 60 falls annually in which an employee uses a belt or harness to arrest a potentially fatal fall.[504] Therefore, employees who rely only on a belt to arrest a potentially fatal fall are still at significant risk of serious injury or death. The use of a body belt as part of a fall arrest system is generally inappropriate as OSHA already established with an extensive record on the subject in the final rule for fall arrest equipment in construction. (For a complete discussion of this issue, see the Summary and Explanation section of the preamble to the final OSHA rule on fall arrest equipment in construction (59 FR 40672, Aug. 9, 1994).)

Appendix to Section VI.E, Benefits, Net Benefits, and Cost Effectiveness—Break-Even Sensitivity Analysis, Including Provision-by-Provision Analysis

1. Introduction

This supplemental analysis provides additional insight into the effect of possible uncertainties on the benefits and costs of the final rule and contains a break-even sensitivity analysis of the possible benefits and costs of the final rule on a provision-by-provision basis. As noted earlier in this section of the preamble, the OSH Act does not require that OSHA standards meet an overall benefit-cost test or that individual provisions have incremental benefits that exceed costs. Thus, OSHA is providing this supplemental analysis purely for the purpose of aiding public understanding of the benefits and costs of the final rule, and this analysis is not necessary, or used, to meet the requirements of the OSH Act with respect to the final rule.

Section V, Summary and Explanation of the Final Rule, earlier in this preamble, provides a justification for each provision of the final rule. However, OSHA provides this supplemental analysis to assess provisions with substantial costs, including two types of training; information transfer; job briefing; aerial-lift fall protection; climbing fall protection; minimum approach distance and working position; and arc-flash protection.[505] Accordingly, we will not be analyzing provisions in the final rule contained in existing § 1910.269.

Because the final rule contains jointly interacting and overlapping provisions, there are two logistical issues with performing a provision-by-provision sensitivity analysis of whether benefits exceed costs in this case: (1) The available data do not permit OSHA to determine the numbers of accidents that every combination of provisions could prevent; and (2) a simple marginal analysis will not fully address the question of whether benefits exceed costs for the rule as a whole. It might, for example, take two or more provisions to prevent a class of accident: A requirement to do x if y would need, not only a requirement to do x if y, but also a requirement to train workers to do x, as well as a requirement to inform workers of when y is the case. In such circumstances, while each provision alone might pass a marginal benefit-cost test, all of the provisions together might not pass a benefit-cost test because the provisions would prevent the same accidents. The three provisions, each costing $5 million (for a total cost of $15 million), might prevent only $12 million worth of accidents because the three provisions would prevent the exact same accidents. Thus, even if a provision-by-provision sensitivity analysis were possible for this rule, that analysis would still not justify the overall combination of provisions. Moreover, for the purpose of determining whether benefits of a rule exceed the costs, one cannot simply test each provision individually, but must find ways to examine situations involving likely joint effects of the provisions of the rule.

This two-part supplemental analysis addresses both of these problems and takes the form of a break-even sensitivity analysis that compares the potential benefits of a given individual provision against the costs of both that provision and, separately, all provisions that, when combined, achieve those particular benefits. Thus, a break-even sensitivity analysis in this case represents an estimate of the percentage of potentially preventable accidents that an individual provision, or a combination of provisions, must prevent for the benefits to equal the costs. Any percentage greater than this percentage would result in benefits exceeding costs.

OSHA began this analysis by conducting a new analysis of the existing accident record, rather than trying to build off of the existing analysis. This supplemental analysis reviewed each accident and indicated each provision that could have had an effect in preventing the accident. Unlike the analysis performed by CONSAD for the proposal, the new approach simply determined that a provision might have prevented an accident, but did not attempt to assign an accident-by-accident probability of prevention. OSHA took this new approach for two reasons: (1) The new approach enabled OSHA to conduct a more reproducible analysis of the accidents than did the analysis CONSAD conducted for the proposal because there were no expert judgments on probability of prevention; and (2) the new approach enabled OSHA to calculate the percentage of accidents that a given provision or combination of provisions needs to prevent to assure that the provision or combination of provisions passes the aforementioned test for cost-effectiveness, and then discuss the reasonableness of that percentage.

OSHA used the results of the new analysis of the accident record in three ways. First, OSHA determined the frequency with which each single provision would have to prevent potentially preventable accidents for benefits to exceed costs for that provision. Second, to further address the issue of joint prevention effects, OSHA conducted an analysis that: Noted the combinations of provisions that were necessary to prevent different kinds of accidents; allocated the costs of each provision according to the percentage of each type of accident that provision likely would prevent; and analyzed the break-even conditions needed for the combined costs of the relevant provisions to be less than, or equal to, the benefits of the accidents those provisions likely would prevent. Finally, OSHA used the two sensitivity analyses it conducted (that is, the analysis showing the break-even point for each single provision and the alternative analysis showing the break-even point for combined provisions) to further bolster the conclusion OSHA drew, in its main analysis, that the benefits of the final rule as a whole exceed the costs of the final rule as a whole.

2. Accident Analysis

The first step in each of these analyses was to examine accident records to determine how many fatalities and nonfatal injuries the relevant provisions of the final rule could potentially prevent. In its accident analysis for the proposed rule, CONSAD examined relevant accident data from OSHA's Integrated Management Information System (IMIS) for the period of January 1, 1994, to March 31, 2000 (Ex. 0031). OSHA reviewed accidents in CONSAD's analysis that

[502] These documents are legacy exhibits 2–36, 3–7, 3–9, 3–10, and 3–13 in OSHA Docket S–206 (Fall Protection).

[503] These documents are legacy exhibits 9–33, 11–3, 11–4, 11–5, and 11–6 in OSHA Docket S–700A (Powered Platforms).

[504] OSHA calculated the annual number of nonfatal falls as follows: X (total number of falls) multiplied by 1/5 (that is, a 20-percent noncompliance rate) = 15 fatal falls; solving for X (that is, 5 × 15), the total number of falls is 75, of which 60 (80 percent) are nonfatal and 15 (20 percent) are fatal.

[505] The chief costs that we are not analyzing are training and other costs for employers not covered by existing § 1910.269. OSHA covered the justification for those costs in a previous rulemaking.

occurred on or after January 1, 1995—a total of 268 accidents.[506] For each accident, OSHA identified the provisions with costs in the final rule that could help prevent the accident. Table 23 lists the general criteria OSHA used to evaluate each accident, and the discussion that follows explains in greater detail how the Agency applied these criteria and how complying with the respective provisions in the final rule would contribute to the prevention of accidents in each category. The full details of this accident analysis are in a printout [1] and a spreadsheet [2] showing the analysis of each accident, including both the original accident description and any comments on why OSHA classified the accident the way it did.[507]

Note that the individual accident abstracts do not typically indicate whether: A host employer provided a contract employer with available information about the installation involved in the accident; the employer provided the employee in charge with such information; or employees received training on the work practices required by the final rule and involved in the accident. Thus, OSHA can only state that the accidents were of a kind that information-transfer, job-briefing, or training would prevent, but not whether there actually was adequate information transfer, job briefings, or training. OSHA considers the information-transfer, job-briefing, and training requirements to be prerequisites for compliance with the work practices in the final rule. Without sufficient information about the characteristics and conditions of the work and the training on work-practices that the final rule requires, employees are not likely to be capable of safely completing the work or following those work practices. For example, if employees do not know the voltage of exposed live parts, they will not be able to determine the appropriate minimum approach distance or select a safe work position with respect to those live parts. As noted under the summary and explanation for final §§ 1926.950(c) and 1926.952(a)(1), host employers do not always provide adequate information to contract employers (see, for example, Tr. 877–878, 1240, 1333), and employers do not always provide adequate information to employees in charge (see, for example, Ex. 0002[508]). In addition, as explained in the summary and explanation for final § 1926.950(b), rulemaking participants broadly recognized the importance of training to ensure that employees use the safety-related work practices required by the final rule (see, for example, Ex. 0219; Tr. 876). OSHA, therefore, considers the information-transfer, job-briefing, and training requirements to be necessary complements to the work-practice requirements in the final rule, including the fall-protection, approach-distance, and arc-flash-protection provisions. Consequently, the Agency attributed some accidents, in part, to the employer's failure to provide contract employers with the needed information to comply with the final rule or employees with the needed information or training to comply with the work practices the final rule requires, even if the accident abstracts did not clearly indicate that contract employers or employees lacked such information or training.[509] However, in cases in which the accident description indicated that appropriate information transfers (between host employers and contract employers or from the employer to the employee in charge) or training took place, OSHA did not deem the accident potentially preventable by the information-transfer, job-briefing, or training provisions.

TABLE 23—GENERAL CRITERIA FOR DETERMINING WHETHER COST-RELATED PROVISIONS MIGHT HAVE PREVENTED ACCIDENTS

Categories of requirements	Criteria
Information-transfer requirements (final §§ 1910.269(a)(3) and 1926.950(c)).	The accident occurred to an employee working for an employer classified under a construction SIC (primarily, 1623 and 1731), or the abstract otherwise indicated that the employer was performing work under contract to a utility, and information required by the final rule was necessary for compliance with provisions related to the accident.
Job-briefing requirements (final §§ 1910.269(c)(1)(i) and 1926.952(a)(1)).	Information required by the final rule was necessary for compliance with provisions related to the accident.
Fall protection for employees in aerial lifts (final § 1910.269(g)(2)(iv)(C)(1)).	The accident involved a fall from an aerial lift by an employee working for a line-clearance tree-trimming firm (SIC 0783) or for an employer that was not a utility or a contractor.
Fall protection for employees on poles, towers, or similar structures (final §§ 1910.269(g)(2)(iv)(C)(3) and 1926.954(b)(3)(iii)(C)).	The accident involved a fall by an employee climbing or changing location on a pole, tower, or similar structure.
Minimum approach distances and working position (final § 1910.269(l)(3), (l)(4)(ii), and (l)(5)(ii), and final § 1926.960(c)(1), (c)(2)(ii), and (d)(2)).	The accident involved an employee who approached too close to an energized part, including employees who were not using electrical protective equipment for voltages of 301 V to 72.5 kV. Note that this category does not include accidents involving contact through mechanical equipment.
Arc-flash protection (final §§ 1910.269(l)(8) and 1926.960(g))	The accident involved an employee burned by an electric arc, injured by flying debris from an electric arc, or burned by clothing ignited by an electric arc (including electric arcs from direct contact) or by burning material ignited by an electric arc.

[506] OSHA began its analysis with the 1995 accidents because some major provisions of the 1994 § 1910.269 final rule, including the training requirements, did not go into effect until 1995. The 268 accidents included all accidents of a type that the proposed rule was trying to prevent. However, as shown in this analysis, OSHA ultimately determined that not all of those accidents were potentially preventable by provisions in the final rule.

[507] For each accident, the printout displays: Information about the accident, including the accident abstract and information on the injuries resulting from the accident; inspection information, including the industry classification for the employer and citations issued to the employer; and the results of the analysis, including comments. In some cases, the printout truncated the accident abstract, citation data, or injury lines because of limitations on the length of the related field. However, the complete record is available on OSHA's Web site through the hyperlink for the inspection record.

The spreadsheet contains the following information about each accident: The accident form number; a hyperlink to the accident on OSHA's Web page; the date of the accident; a one-line description of the accident; the applicable categories of regulatory provisions (a value of 1 indicates that the category is applicable to the accident); and the comments from the analysis of the accident. On a separate worksheet, the spreadsheet calculates the percentage of the total number of accidents that are potentially preventable by each category of provisions.

[508] See, for example, the three accidents at *http://www.osha.gov/pls/imis/accidentsearch.accident_detail?id=14418941&id=200960060&id=642975*, in which employers did not provide sufficient information to employees about the extent of a deenergized area, the location of circuits, and the location of disconnects, respectively.

[509] OSHA performs its accident investigations as part of the Agency's inspection activities and focuses those investigations on determinations of compliance with existing standards. Because existing § 1910.269 and Subpart V do not require the exchange of information between host and contract employers, or between employers and employees in charge, required by this new final rule, OSHA compliance staff generally do not determine whether such an information exchange takes place or, if they do make such a determination, they do not include the results of the determination in the accident abstracts.

TABLE 23—GENERAL CRITERIA FOR DETERMINING WHETHER COST-RELATED PROVISIONS MIGHT HAVE PREVENTED ACCIDENTS—Continued

Categories of requirements	Criteria
Training (final §§ 1910.269(a)(2)(i) and 1926.950(b)(1))	Any accident included under any category other than information transfer and job briefing, and any other accident involving work practices that would change as a result of revisions to existing § 1910.269 made in the final rule. (Note that employees must be trained in the work practice changes included in the final rule to achieve the benefits from the changes in those work practices.)

Note: This table summarizes the general criteria for a category of requirements, but does not include all refinements on these criteria. The full text provides additional qualifying criteria not included in the table.

Information-Transfer Requirements

The information-transfer requirements in final §§ 1910.269(a)(3) and 1926.950(c) require host employers (generally electric utilities) to exchange specified information with contract employers (generally construction firms) so that each employer can comply with the final rule to protect its employees. OSHA identified accidents in which an employer that appeared to be a contract employer (that is, employers in construction SICs, except as otherwise noted in the comments to individual accidents) needed specific information to comply with the final rule. The comments note the type of information, such as voltage or incident energy, that the contract employer would need to comply with requirements in the final rule.

For example, in many instances, a contractor employee approached too closely to an energized part.[510] In these cases, the contract employer needed, but might not have had, information on the voltage of energized parts involved in the accident. With that information, employees would be more likely to use the appropriate minimum approach distance and less likely to experience the accident. However, OSHA did not include in this category accidents in which there was an explicit notation or clear implication in the abstract that the employer knew the voltage.

In other instances, a contractor employee was exposed to an electric arc.[511] In these cases, the contract employer needed, and might not have had,[512] information on incident heat energy to provide employees with appropriate protection against electric arcs and to prevent or reduce the severity of injuries resulting from the accident. OSHA did not include in this category accidents in which employees received burns from hydraulic fluid ignited by electric arcs because the required information has no bearing on these accidents.

Job-Briefing Requirements

The job-briefing requirements in final §§ 1910.269(c)(1)(i) and 1926.952(a)(1) specify that employers provide employees in charge with certain information. OSHA identified accidents in which employees needed the required information to adhere to the work practices required by the final rule.[513] For example, in many instances, an employee approached too closely to an energized part.[514] In such cases, employees needed, but might not have had, information on the voltage on energized parts so that they could maintain the appropriate minimum approach distances from those energized parts and, based on that information, select appropriate electrical protective equipment rated for the voltage. However, OSHA did not include in this category accidents in which there was explicit notation or clear implication in the abstract that the employees knew the voltage.

In other instances, employees needed, and might not have had, information on incident heat energy so that they could wear appropriate protection against electric arcs to prevent or reduce the severity of injuries resulting from the accident.[515] However, OSHA did not include in this category accidents involving employees burned by direct contact with energized parts unless the employees' clothing ignited.[516]

In a few instances, employees needed other required information, such as information on the condition of poles, to select appropriate work practices, such as installing bracing to those poles to prevent them from failing or falling over.[517] The Agency did not include in this category one instance in which an on-site supervisor was aware of the conditions causing a pole to collapse.

OSHA recognizes that, in some of the accidents counted in this category, the relevant information might not have been available to the employer at the time of the accident; and, therefore, the employer could not provide that information to the employee in charge. However, if the information was available, the employer, under the final rule, would have to provide it to the employee in charge, making it more likely that employees would select compliant work practices and, consequently, lessen the likelihood of the accident.

Fall Protection for Employees in Aerial Lifts

The requirement for fall protection for employees in aerial lifts in final § 1910.269(g)(2)(iv)(C)(1) ensures that employees working from aerial lifts use body harnesses to protect against injuries resulting from falls. OSHA identified accidents involving employees falling from aerial lifts.[518] The Agency did not include accidents involving aerial lifts overturning or aerial-lift failure unless the accident abstract indicated that such an event ejected the employee from the aerial lift platform and that the employee might have suffered less severe injuries in the fall had the employee been wearing a body harness. The comments included in the analysis of these accidents explain OSHA's reasoning in such cases.

Note that, unless the abstract indicated that body harnesses were the employer's required form of fall protection, the Agency included in this category accidents involving employees not wearing any fall protection because the final rule makes it more likely that employees will use fall protection.[519]

[510] See, for example, the five accidents at: *http://www.osha.gov/pls/imis/establishment.inspection_detail?id=121317119&id=106549090&id=108964321&id=126680362&id=301305058.*

[511] See, for example, the five accidents at: *http://www.osha.gov/pls/imis/establishment.inspection_detail?id=122248933&id=123255036&id=119572378&id=125310748&id=113324040.*

[512] Because existing § 1910.269 and Subpart V do not require employers to protect employees from arc-flash hazards, OSHA assumes that contract employers generally do not already have information on incident heat energy.

[513] Such cases include all cases captured by the information-transfer category. These cases also include similar cases involving employees of host employers.

[514] See, for example, the five accidents involving employees of a host employer at: *http://www.osha.gov/pls/imis/establishment.inspection_detail?id=125850560&id=107095234&id=126603075&id=126480821&id=114145840.*

[515] See, for example, the five accidents involving employees of a host employer at: *http://www.osha.gov/pls/imis/establishment.inspection_detail?id=119617454&id=125958280&id=112130158&id=106447691&id=119541977.*

[516] The arc-flash protection requirements in the final rule protect employees against burns resulting from incident heat energy from an electric arc or resulting from clothing or other material ignited by the incident heat energy from the electric arc. When the employee's clothing ignited in a direct-contact incident, OSHA assumed that the ignition resulted from the electric arc that occurred during contact. Otherwise, OSHA assumed that the burns resulted from current passing through the employee's body. The arc-flash protection requirements will not prevent the latter type of burn.

[517] See, for example, the two accidents at: *http://www.osha.gov/pls/imis/establishment.inspection_detail?id=125773978&id=302868344.*

[518] See the three accidents at: *http://www.osha.gov/pls/imis/establishment.inspection_detail?id=127350080&id=301827531&id=301994091.*

[519] See the summary and explanation of final § 1926.954(b)(1)(i), which explains that requirements associated with using body harnesses are easier for employers to enforce than requirements associated with using body belts.

Fall Protection for Employees on Poles, Towers, or Similar Structures

The final rule, at §§ 1910.269(g)(2)(iv)(C)(3) and 1926.954(b)(3)(iii)(C), requires qualified employees climbing and changing location on poles, towers, or similar structures to use fall protection. OSHA identified accidents involving employees falling while climbing or changing location on poles, towers, and similar structures.[520] The Agency did not include in this category accidents involving employees falling while at the work location (as opposed to during climbing or while changing location) because the existing standards require the use of fall protection in such circumstances. Nor did the Agency include accidents involving employees falling from ladders or structures that do not support overhead power lines because the relevant fall protection requirements in the final rule do not apply to ladders or structures that do not support overhead power lines. Finally, OSHA did not include in this category accidents involving falls resulting from the failure of a pole, tower, or structure.

OSHA recognizes that the final rule does not require an employee to use fall protection while the employee is climbing or changing location on poles, towers, or similar structures when 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 fall protection. Although OSHA was unable to determine whether any of the accidents involved situations in which this exception would apply, the Agency anticipates that the exceptions would apply only in unusual, and relatively rare, instances. Consequently, the Agency did not exclude any of the accidents on this basis and determined that the final rule could prevent nearly all accidents of this type.

Minimum Approach Distances and Working Position

The approach-distance requirements in final § 1910.269(l)(3), (l)(4)(ii), and (l)(5)(ii), and final § 1926.960(c)(1), (c)(2)(ii), and (d)(2), require that employees maintain the employer's established minimum approach distances and ensure that employees within reach of those minimum approach distances are using electrical protective equipment or are otherwise protected against electric shock.[521] OSHA identified accidents in which the final rule would make it more likely that employees would use electrical protective equipment or in which substantially larger minimum approach distances would make it less likely that an unprotected employee would come too close to an energized part. Although other provisions in the standard require that employers ensure that employees maintain the employers' established minimum approach distances in specific circumstances, for example, during the operation of mechanical equipment, this analysis does not account for benefits resulting from increases in minimum approach distances in those other circumstances.[522]

The final rule generally prohibits employees who are not using some form of electrical protective equipment or live-line tools from being within reach of the minimum approach distance of exposed parts energized at more than 600 volts, but not more than 72.5 kilovolts (final § 1910.269(l)(4)(ii) and (l)(5)(ii), and final § 1926.960(c)(2)(ii) and (d)(2)). Existing § 1910.269 contains no such provisions; therefore, the final rule provides increased protection in these circumstances and makes accidents less likely. In addition, the final rule adopts minimum approach distances that are substantially greater than the corresponding minimum approach distances in existing § 1910.269 for voltages between 301 and 1,000 volts and over 72.5 kilovolts.[523] If employers follow the final rule and ensure that employees use substantially greater minimum approach distances at these voltages, then it is less likely that an unprotected employee will approach too close to an exposed energized part.

OSHA identified accidents in which employees who were not using electrical protective equipment or live-line tools contacted, or approached too close to, exposed circuit parts energized at 301 volts or more.[524] Although the accident abstracts typically state that the employee "contacted" an energized part, at the voltages commonly encountered in transmission and distribution work, the air between the worker and the energized part will break down dielectrically before the employee can contact the part. Whether the employee pulls away or subsequently touches the energized part will not affect the outcome—that is, electric shock, and potentially electrocution, and burns from current passing through the skin and from exposure to the electric arc carrying current to the energized part. Consequently, OSHA concludes that all "contact" accidents involve a sparkover across an air gap and not actual contact with the energized part.[525]

Furthermore, for several reasons, increasing the minimum approach distance will decrease the likelihood that an employee will approach closely enough for sparkover. First, the increases in minimum approach distance, though slight in most cases, reduce the probability of sparkover to 3σ (approximately 1 in 1,000) from sometimes substantially higher probabilities. (For example, the probability of sparkover at the electrical component of the existing phase-to-phase minimum approach distance for an 800-kilovolt system with a 2.5-per unit maximum transient overvoltage is approximately 6 in 10.) Second, the increased distance will provide the employee with additional distance, and thus time, to detect and withdraw from an approach that is too close to energized parts. (See the summary and explanation of final § 1926.960(c)(1) under the heading "The ergonomic component of MAD" in Section V, Summary and Explanation of the Final Rule, earlier in this preamble, for further information.) Third, the increased distance provides a greater margin of error for the employee in the absence of a known maximum transient overvoltage.

The Agency did not, however, include certain types of accidents under this category. First, the Agency did not include accidents involving mechanical equipment, loose conductors, or guys[526] that contacted overhead power lines energized at less than 72.6 kilovolts. The revised requirements in the final rule do not increase the likelihood of preventing such accidents because the minimum approach distances at those voltages are substantially the same as the distances in existing § 1910.269, and the revised work-positioning requirements in the final rule generally do not address hazards associated with these accidents.

Second, OSHA did not include accidents in which the abstract indicated that an employee contacted an energized part that the employee incorrectly believed to be deenergized, except when information on the location of circuits and their voltages would

[520] See, for example, the five accidents at: *http://www.osha.gov/pls/imis/establishment.inspection_detail?id=123997892&id=120080296&id=125864686&id=126603075&id=126053644.*

[521] The benefits of these provisions relate to the final rule's costs, either directly (see discussion of costs of minimum approach distance provisions in the FEA) or indirectly (because employees will need training in the revised work practices contained in the provisions).

[522] These additional approach-distance requirements are in final §§ 1910.269(p)(4) and 1926.959(d) (for the operation of mechanical equipment), final §§ 1910.269(q)(3)(vi), (q)(3)(xiv), (q)(3)(xv), and (q)(3)(xvi) and 1926.964(c)(5), (c)(13), (c)(14), and (c)(15) (for live-line barehand work), and final § 1910.269(r)(1)(iii), (r)(1)(iv), and (r)(1)(v) (for line-clearance tree-trimming work).

[523] Under existing § 1910.269, the minimum approach distance for voltages of 50 to 1,000 volts is the statement, "avoid contact." The final rule requires the employer to establish a minimum approach distance of not less than 0.33 meters (1.09 feet) for voltages of 301 to 750 volts and not less than 0.63 meters (2.07 feet) for voltages of 751 to 5,000 volts.

The default minimum approach distances in Table R–7 and Table V–6 in the final rule provide substantially larger minimum approach distances than the minimum approach distances in Table R–6 in existing § 1910.269 for voltages above 72.5 kilovolts. Under the final rule, employers may establish their own minimum approach distances, which may be the same as the minimum approach distances in existing Table R–6, in lieu of using the default distances; but, for the purposes of this analysis, OSHA assumed that employers would use the default minimum approach distances. Even if employers establish smaller minimum approach distances than the default distances, the final rule requires that such distances ensure that the probability of sparkover at the electrical component of the minimum approach distance is no greater than 1 in 1,000, which makes the probability of an accident less likely than under the existing standard.

[524] See, for example, the five accidents at: *http://www.osha.gov/pls/imis/establishment.inspection_detail?id=122193329&id=109573204&id=122194707&id=109298216&id=125652016.*

[525] As detailed in the summary and explanation of final § 1926.960(c), in Section V, Summary and Explanation of the Final Rule, earlier in this preamble, the sparkover distance at the worksite depends on several factors, including, in particular, the nominal voltage on the system and any transient overvoltage that occurs while the employee is working.

[526] A guy is a tensioned cable, or wire rope, that adds stability and support to structures carrying overhead power lines.

have informed the employees that lines or equipment were energized.[527] Provisions for deenergizing and grounding lines and equipment in the existing standard address these hazards, and the final rule does not revise those provisions.

Third, OSHA did not include accidents in which the abstract indicated that the employee was using, or likely was using, appropriate electrical protective equipment or live-line tools. The revised work-positioning requirements would not apply in such cases.

Arc-Flash Protection

Final §§ 1910.269(l)(8) and 1926.960(g) require the employer to provide, and ensure the use of, appropriate protective clothing and equipment to either prevent or reduce the severity of injuries to employees exposed to electric arcs. OSHA identified accidents in which employees sustained burns and other injuries from electric arcs.[528]

The Agency did not include accidents in which employees directly contacted energized parts unless: (1) The employee survived the electric shock and (2) the employee sustained burns or other arc-flash injuries to parts of the body other than the hands and feet. In the analysis, OSHA assumes that rubber insulating gloves with leather protectors worn in compliance with the approach-distance requirements will protect against burns to the hands. OSHA also assumes that the injured employee was wearing heavy-duty work shoes or boots that comply with the arc-flash protection requirements in the final rule. Based on the analysis of the accident data, such footwear will protect against exposure to electric arcs, but will not protect against burns resulting from dielectric failure of the footwear, which can occur in cases of direct contact with high-voltage energized parts.

In addition, OSHA did not include accidents in which employees received burns from hydraulic fluid ignited by an electric arc, unless the burning hydraulic fluid ignited the employee's clothing. The Agency assumes that the arc-flash provisions in the final rule will not prevent, or substantially reduce, injuries caused by the heat from burning hydraulic fluid.

Training

OSHA did not substantially revise the training requirements in existing § 1910.269. However, employers will incur costs for training employees. Even though employees already are trained in the work practices required by existing § 1910.269, additional training costs will result because employers must train workers in the revised work practices required by the final rule. The additional training requirements provide benefits because trained employees are more likely to follow the work practices specified by the standard than untrained employees.

The Agency identified accidents involving incorrect work practices that the final rule will prevent.[529] Specifically, OSHA included in this category any accident included in the fall-protection, approach-distance, or arc-flash categories described earlier. The work-practice changes required in those areas in the final rule will result in new training, which, in turn, will make accidents included in the training category less likely.

3. Results of Accident Analysis

Table 24 presents the results of OSHA's analysis of the CONSAD accident data. The first column in that table lists the categories of provisions in the final rule included in this analysis, while the second column presents the number of accidents that the requirements in each of these categories likely will prevent. For example, the information-transfer requirements in the final rule make 77 of the accidents less likely to occur in comparison with the existing standards. The third column of Table 24 shows the corresponding percentage of accidents that the requirements in each of these categories likely will prevent. For example, the approach-distance requirements in the final rule make 35.8 percent of the accidents less likely to occur in comparison with the existing standards.

TABLE 24—PERCENTAGE OF ACCIDENTS ADDRESSED BY EACH CATEGORY OF PROVISION

Category of provision	Number of accidents addressed by the provision	Percentage of 268 total accidents addressed by the provision
Information Transfer	77	28.7
Job Briefing	153	57.1
Training	144	53.7
Aerial Lift Fall Protection	3	1.1
Climbing Fall Protection	10	3.7
Approach Distance	96	35.8
Arc Flash	42	15.7

4. Provision-by-Provision Sensitivity Analysis

To conduct its provision-by-provision sensitivity analysis, OSHA first compared the percentage of accidents in each category (from Table 24) against the estimated total number of fatalities involving circumstances directly addressed by the final rule, 74 annually, and the corresponding number of serious injuries, 444 annually. OSHA next estimated the economic value of those prevented fatalities and injuries.[530] Finally, OSHA estimated the percentage of provision-relevant benefits that would be necessary to establish that a particular provision produces zero net benefit (that is, the estimated value of the prevented accidents equals the estimated cost of the related provision). Any percentage greater than this will produce positive net benefits. Table 25 shows the results of this analysis.

As noted earlier in the accident analysis, the Agency sometimes attributed an accident to a provision even though it was unclear from the accident abstract whether the employer followed that provision on a voluntary basis. Therefore, although Table 25 accounts for baseline compliance in terms of costs, Table 25 does not account for baseline compliance in terms of potential monetized benefits. Table 26, on the other hand, accounts for baseline compliance in terms of both costs and benefits.

OSHA notes that accounting for baseline compliance is difficult because effectiveness and baseline compliance interact for purposes of estimating the number of accidents where there is no baseline compliance. For example, if a provision is so effective that there would be no accidents so long as employers follow the regulation, then all accidents attributed to that provision would necessarily occur when employers did not follow the provision; and OSHA, therefore, could state with 100 percent certainty that employers did not follow the provision voluntarily. Conversely, if the provision is completely ineffective, the associated injury and fatality rate for employers in voluntary compliance will be

[527] An example of the exception is an accident in which an employer assigns a crew to work on one line the crew correctly believes is deenergized, but a crew member accidentally works on a wrong line, which is energized. Information on the correct location of lines and which lines are energized would help prevent such accidents.

[528] See, for example, the five accidents at: *http://www.osha.gov/pls/imis/establishment.inspection_detail?id=119617454&id=125958280&id=112130158&id=106447691&id=119541977.*

[529] See, for example, the five accidents at: *http://www.osha.gov/pls/imis/establishment.inspection_detail?id=123997892&id=119617454&id=125958280&id=123383382&id=124822347.*

[530] Note that, due to data limitations discussed in the body of the FEA, OSHA could not identify or evaluate injuries with the same degree of accuracy as fatalities. For that reason, throughout this analysis, estimated injuries are in fixed proportion to estimated fatalities. Note, also, that prevented injuries comprise only a minor percentage of the total benefits of the rule.

the same as for employers not in voluntary compliance. As a result, the expected percentage of associated injuries and fatalities for firms in voluntary compliance will equal the percentage of employees in firms in voluntary compliance (as a percentage of all employees with associated injuries and fatalities). Thus, if 20 percent of employees work in firms in voluntary compliance with a completely ineffective provision, then 20 percent of all associated injuries and fatalities will occur among these employees, assuming an equal distribution of affected work. OSHA examines intermediate cases, which are more complex to calculate, in a spreadsheet showing the calculation of breakeven rates taking account of baseline compliance [9].

Table 26 shows estimated rates of baseline compliance for each provision and the resulting percentage of potential benefits needed for benefits to equal costs, adjusted for the compliance rate using the methodology. The compliance rates show that, for all provisions, with the exception of new requirements for calculating minimum approach distances, industry already bears most of the costs voluntarily. As expected, the break-even rates in Table 26 usually are higher than the rates shown in Table 25. In some cases, as discussed later, OSHA believes that accidents addressed by individual provisions could not occur in the event of full compliance with the final rule. In these cases, the last column of Table 26 shows a range of potential benefits needed to break even with costs, with the percentage in that column, adjusted for baseline compliance, representing the top end of the range, and the percentage from the last column of Table 25 representing the bottom end of the range. OSHA believes the percentage at the top end of the range is premised on an incorrect assumption—that relevant accidents can occur even with full compliance with the final rule.

TABLE 25—SENSITIVITY ANALYSIS OF POTENTIAL BENEFITS FROM DIFFERENT PROVISIONS OF THE ELECTRIC POWER GENERATION, TRANSMISSION, AND DISTRIBUTION STANDARD

Category of provision	Annualized cost of compliance	Percentage of accidents addressed by the provision (from Table 24)*	Fatalities prevented†	Monetized benefits of fatalities potentially prevented‡	Injuries potentially prevented§	Monetized benefits of injuries potentially prevented**	Total potential monetized benefits	Percentage of potential benefits needed to break even with costs††
Information Transfer	$17,820,841	28.7	21.5	$184,770,600	127.4	$7,900,536	$192,671,136	9.2
Job Briefing	6,697,557	57.1	42.3	367,609,800	253.5	15,718,488	383,328,288	1.7
Training	2,950,935	53.7	39.7	345,720,600	238.4	14,782,536	360,503,136	0.8
Aerial Lift Fall Protection	113,222	1.1	0.8	7,081,800	4.9	302,808	7,384,608	1.5
Climbing Fall Protection	451,768	3.7	2.7	23,820,600	16.4	1,018,536	24,839,136	1.8
Approach Distances	1,807,505	35.8	26.5	230,480,400	159.0	9,855,024	240,335,424	0.8
Arc Flash	19,446,147	15.7	11.6	101,076,600	69.7	4,321,896	105,398,496	18.5

*Total exceeds 100 percent because more than one provision may prevent a given accident.
†Percentage of accidents addressed multiplied by 74 (the number of fatalities of the type addressed by the final rule).
‡thnsp;Valued at $8.7 million per fatality.
§ Percentage of accidents addressed multiplied by 444 (the number of injuries of the type addressed by the final rule).
**Valued at $62,000 per injury.
††The Percentage of Potential Benefits Needed to Break Even with Costs derived by dividing the monetized benefits in column 8 by the costs in column 2.
Note: Totals may not equal the sum or product of the components due to rounding.

TABLE 26—BASELINE COMPLIANCE RATES AND PERCENTAGE OF POTENTIAL BENEFITS NEEDED TO BREAK EVEN WITH COSTS, GIVEN BASELINE COMPLIANCE

Category of provision	Baseline compliance* (percent)	Percentage of potential benefits that need to be realized to break even with costs, adjusted for baseline compliance†
Information Transfer	77	31.6
Job Briefing	96	31.7
Training	95	14.7
Aerial Lift Fall Protection‡	65	1.5–4.4
Climbing Fall Protection‡	50	1.8–3.7
Approach Distances‡	0	0.8
Arc Flash‡	81	18.5–55.6

*Calculated as the percentage of costs for projects already in compliance as a percentage of costs if no firms were in compliance.
†See reference [9] for method of calculation.
‡It is possible that baseline compliance may be irrelevant because no accidents could occur (or, in the case of the arc-flash provisions, no fatalities could occur, and the final rule would significantly reduce the incidence of serious burns) in the event of 100-percent compliance, in which case the break-even percentage is the same as in Table 25.

Before discussing the results of Table 25 and Table 26, OSHA will address the potential preventability of the types of accidents the final rule likely will prevent. Generally, no set of controls can prevent all accidents associated with a particular activity and still allow workers to engage in the activity at reasonable cost. For example, controls cannot prevent fully many kinds of accidents, such as transportation accidents or slips and trips. However, this is not the case for many of the hazards addressed by this final rule. The fall, burn, and electric-shock accidents that this standard addresses are almost completely preventable with appropriate, affordable precautions. The final rule addresses the problem that, in many cases, employers do not apply known, effective controls, either because no rule requires such controls or because individual employers may lack the information to apply required controls properly.

Because the benefits of information transfer, job briefings, and training depend in part on the effectiveness of other provisions, OSHA will first consider the effectiveness of provisions involving aerial lift and climbing fall protection, approach distances, and arc-flash protection. In evaluating the likelihood of meeting any of the calculated break-even effectiveness rates, there are several key factors to consider: The potential that a provision could prevent an accident; the extent to which full compliance with existing rules could prevent the accident; and, even if full compliance with existing rules could prevent an accident, the extent to which the provision makes it easier or more likely that there will be greater compliance with existing rules.

Aerial Lift Fall Protection

Under the final rule, employees in aerial lifts performing covered work will not be able to use body belts as part of fall-arrest systems and, instead, must use body harnesses. While perfect compliance with the existing fall-protection provision could prevent most fatalities and some nonfatal injuries, as OSHA stated in Section V, Summary and Explanation of the Final Rule, earlier in this preamble, using body harnesses instead of body belts will not only reduce the number of fatalities and the severity of some injuries, but also increase the probability that employees use fall protection because it is not always possible for an employer to detect from the ground whether an employee is wearing a body belt, but it is relatively easy to determine whether an employee is wearing a body harness.

Table 25 shows that the aerial-lift fall-protection provision addresses 1.1 percent of all accidents OSHA reviewed for this supplemental analysis. Moreover, Table 25 shows that, if compliance with the final rule's aerial-lift fall-protection provision prevents only 1.5 percent of these accidents, then the benefits will meet or exceed the costs. Table 26 shows that, after adjusting for baseline compliance, benefits will meet or exceed the costs if the provision, including the correct use of body harnesses, prevents 4.4 percent or more of these accidents.[531]

[531] OSHA uses the term "these accidents" in this and similar portions of the text to refer to the percentage of the percentage of total accidents that a particular provision needs to prevent for the benefits of that provision to meet or exceed the costs of that provision. For example, OSHA says in the text that "Table 25 shows that the aerial-lift fall-protection provision addresses 1.1 percent of all accidents OSHA reviewed for this analysis," and that "if compliance with the final rule's aerial-lift fall-protection provision prevents only 1.5 percent of these accidents, then the benefits will meet or exceed the costs." This statement means that Table 25 shows that benefits will meet or exceed costs if compliance with the final rule's aerial-lift fall-protection provision prevents 1.5 percent of the 1.1 percent of total accidents that compliance with the

Continued

Ignoring the benefits resulting from the decrease in the number and severity of injuries from falls into body harnesses in comparison to falls into body belts, OSHA concludes that the increased probability that workers subject to the final rule will use fall protection is sufficient reason alone to assure a 4.4 percent decrease in accidents involving falls from aerial lifts.

Climbing Fall Protection

The final rule requires that qualified employees use fall protection when climbing or changing location on poles, towers, or similar structures. Existing fall protection standards do not require the use of fall protection in these circumstances. Therefore, full compliance with existing rules would not prevent any of the falls OSHA attributed to this provision.

Moreover, proper use of fall protection will prevent almost all fatalities or serious injuries resulting from falls by employees when climbing or changing location on such structures. Table 25 shows that the final rule's climbing fall protection provision addresses 3.7 percent of all accidents and that benefits will meet or exceed the costs if use of fall protection prevents 1.8 percent or more of these accidents. Since it is nearly impossible for an accident to occur if employers comply fully with these provisions, it is reasonable to conclude that baseline compliance is irrelevant and that 1.8 percent remains the relevant break-even percentage even when considering existing compliance. OSHA believes that, given that full compliance with this requirement will prevent almost all fatalities and serious injuries from falls under these circumstances, it is reasonable to conclude that this provision will have benefits that exceed costs.

Approach Distances

The approach-distance provisions require employers to ensure that employees who do not use electrical protective equipment or have other protection against electric shock not reach into the employer's established minimum approach distances. The existing rule does not contain similar requirements. Even though full compliance with existing rules may have prevented some of the accidents OSHA attributed to the final rule's provisions, the final rule's provisions will make the maintenance of the minimum approach distance easier or more likely than under the existing rule. Under the final rule's approach, the type of contact accidents OSHA attributed to the final rule's provisions are less likely because an employee following the revised approach-distance requirements would not need to divide his or her attention between performing a job task and maintaining the minimum approach distance. Simply put, the final rule's provisions will minimize the risk that errors in judgment about the minimum approach distance will lead to electrocution.

These provisions also require minimum approach distances that are substantially greater than the corresponding minimum approach distances in existing § 1910.269 for voltages between 301 and 1,000 volts and over 72.5 kilovolts. For reasons stated earlier in this analysis, increasing the minimum approach distance will decrease the likelihood that an employee will approach closely enough to an exposed energized part for sparkover. Therefore, if employers follow the final rule and use substantially greater minimum approach distances at these voltages, then it is substantially less likely that an unprotected employee (that is, an employee not using electrical protective equipment) will approach too close to an exposed energized part.

It is almost certain that full compliance with the final rule would prevent all accidents attributed to these provisions. Table 25 shows that the final rule's minimum approach distance provisions address 35.8 percent of all accidents and that benefits will meet or exceed the costs if the new provisions prevent 0.8 percent or more of these accidents. Moreover, baseline compliance is zero percent in this case; therefore, even if baseline compliance was above zero, since it is nearly impossible for an accident to occur if employers comply with these provisions, it is reasonable to conclude that baseline compliance would be irrelevant, and that 0.8 percent would remain the relevant break-even percentage even when considering existing compliance. Given that full compliance with this requirement will prevent almost all applicable fatalities and serious injuries, OSHA believes that it is reasonable to conclude that this provision will have benefits that exceed costs.

Arc Flash

The final rule contains new provisions addressing arc-flash protection. These new provisions, if followed, will prevent virtually all fatalities, and significantly reduce the incidence of serious burns from arc-flash accidents. The existing rule does not contain such protections. OSHA's existing rule simply requires that an employee's clothing do no greater harm than the harm that the employee would experience without the clothing. As such, it is highly likely that full compliance with existing rules would prevent none of the burn accidents OSHA analyzed.

Moreover, it is almost certain that full compliance with the final rule would prevent the fatalities and reduce the serious injuries resulting from electric arcs. Table 25 shows that the final rule's arc-flash provisions address 15.7 percent of all accidents and that benefits will meet or exceed the costs if the new provisions prevent 18.5 percent or more of these accidents. Compliance with these provisions will almost certainly reduce the severity of burns and will make it is nearly impossible for a fatality to occur.[532] Therefore, it is reasonable to conclude that baseline compliance is irrelevant and that 18.5 percent remains the relevant break-even percentage even when considering existing compliance. OSHA believes that, given that full compliance with these provisions will prevent almost all applicable fatalities and significantly reduce the severity of burn injuries, it is reasonable to conclude that this provision will have benefits that exceed costs.

Information Transfer

The information-transfer provisions require host employers to exchange specified information with contract employers so that each employer can comply with the final rule to protect its employees. The existing rule does not contain such provisions. However, accidents among employers are far more likely to occur when those employers do not have adequate information to comply with requirements that depend on the employer having that information. For example, an employer cannot not select protective grounding equipment meeting existing § 1910.269(n)(4)(i), which requires that protective grounding equipment be capable of conducting the maximum fault current that could flow at the point of grounding for the time necessary to clear the fault, if the employer does not know the fault current or clearing time for a circuit. As such, it is highly likely that the existing rule could not prevent at least some of the accidents OSHA attributed to these provisions because many employers did not have adequate information to achieve full compliance with the existing rule's work practice requirements and, but for the new information-transfer provisions, would not have adequate information to achieve full compliance with the final rule's work-practice requirements.

OSHA also believes that it is likely that the benefits of this provision will exceed the costs. In its analysis, OSHA identified accidents in which an employer that appeared to be a contract employer needed specific information to comply with the final rule. It is necessary that the host employer transfer certain key information about the electric power generation, transmission, or distribution installation to the contract employer, as such information is almost never readily available to the contract employer from any source other than the host employer. Table 25 shows that the final rule's information-transfer provisions address 28.7 percent of all accidents and that benefits will meet or exceed the costs if the new provisions prevent 9.2 percent or more of these accidents. Table 26 shows that, after adjusting for baseline compliance, benefits will meet or exceed the costs if the provisions prevent 31.6 percent or more of these accidents. The transfer of required information is a necessary, but not a sufficient, condition for preventing accidents; therefore, OSHA considers it likely that the final rule will achieve this level of preventability given that the record for this rulemaking clearly shows that contract employers have difficulty meeting the provisions of the existing standard due to a lack of information. In particular, the record shows that contract employers experience a recurring inability to get needed information from utilities. (See, for example, Tr. 877, 1240, 1333.)

final rule's aerial-lift fall-protection provision would potentially prevent.

[532] See the summary and explanation of final § 1926.960(g), in Section V, Summary and Explanation of the Final Rule, earlier in this preamble, for an explanation of how the final rule protects employees from fatal and nonfatal burn injuries.

Job Briefing

The job-briefing provision requires employers to provide certain necessary safety information to the employee in charge. It is important that the employer provide the employee in charge with this information to aid employees' assessment of worksite conditions and, as a secondary precaution, in case employees at the site fail to observe a particular condition related to their safety. The existing standards do not contain such a provision. Moreover, the record makes clear that, under the existing rule, employees do not always have, nor can they always obtain, the necessary information they need to perform their jobs safely because employers are placing the entire burden of compliance with the job-briefing requirement on the employee in charge (see discussion of § 1926.952 in Section V, Summary and Explanation of the Final Rule, earlier in this preamble). As such, it is highly likely that the existing rule could not prevent at least some of the accidents OSHA attributed to this provision because many employees did not have adequate information for employers to achieve full compliance with the existing rule's work practice requirements and, but for the new job-briefing provision, would not have adequate information for employers to achieve full compliance with the final rule's work-practice requirements.

However, under existing § 1910.269(c), employees become aware of at least some of this necessary safety information because, although the existing rule does not require employers to provide this information to the employee in charge, the existing rule requires job briefings that cover hazards associated with the job, work procedures involved, special precautions, energy-source controls, and personal protective equipment requirements. Consistent with this conclusion, Table 25 shows that benefits will meet or exceed the costs if the new provision prevents 1.7 percent or more of the accidents addressed by this provision; Table 26 shows that, after adjusting for baseline compliance, benefits will meet or exceed the costs if the new provision prevents 31.7 percent or more of these accidents.

Table 25 shows that compliance with the final rule's job-briefing provision potentially would prevent a large portion (57.1 percent) of all accidents. As such, it is likely that the benefits of this provision will exceed the costs because of the large percentage of total accidents potentially prevented by this provision (57.1 percent) and the percentage of prevention (31.7 percent) needed for the benefits of these accidents to equal costs. Again, the record evidence supports the conclusion that at least some employees do not have adequate information to perform their jobs safely and, further, that the overwhelming majority of employers do find such job briefings desirable.

Training

The training requirements in the final rule are substantially the same as those in existing § 1910.269. Training costs arise, not from new training requirements, but from the need to provide employees with new training in work practices conforming to new and revised work-practice requirements in the final rule. Consequently, the training required under the existing rule will prevent accidents that only the existing rule's work-practice requirements might prevent, and not accidents that only the final rule's work-practice requirements might prevent.

For example, full compliance with the existing rule's training requirements would not prevent the falls that OSHA attributed to the final rule's climbing fall-protection provision because the existing rule does not require qualified employees to use fall protection when climbing or changing location on poles, towers, or similar structures. However, full compliance with the existing rule's training requirements might prevent some of the falls that OSHA attributed to the final rule's aerial-lift fall-protection provision because full compliance with the existing rule's aerial-lift fall-protection provision would likely prevent some of those accidents. As such, the training required under the existing rule would prevent some, but not all, of the accidents attributed to the training required under the final rule.

In its analysis, OSHA attributed to the training required under the final rule any accident that the Agency attributed to provisions requiring compliance with the final rule's new and revised work-practice requirements (that is, provisions on aerial-lift fall protection, climbing fall protection, information transfer, approach distances, and arc flash). Consequently, the revised training employers will provide under the final rule will prevent some, but not all, of the accidents attributed to training required under the final rule to the same extent as the new and revised work-practice requirements. As such, full compliance with the new training required under the final rule would help prevent the accidents OSHA attributed to the new training precisely because OSHA also attributed those accidents to the new and revised work-practice provisions.

As noted earlier, the training provisions act jointly with the new and revised work-practice requirements in the final rule to prevent accidents. The new and revised work-practice provisions necessitate new training, which, in turn, will make accidents included in the training category less likely. Trained employees are much more likely to follow the work practices required under the final rule than untrained employees. As discussed earlier, it is almost certain that full compliance with the final rule's climbing fall-protection, approach-distance, and arc-flash provisions would prevent all accidents attributed to these provisions. As also discussed earlier, using body harnesses instead of body belts in aerial lifts also will reduce the number of fatalities and the severity of some nonfatal injuries. The training requirements will contribute to this reduction in accidents because those requirements will help ensure full compliance with the final rule's work-practice provisions.

Table 25 shows that compliance with the final rule's training provisions potentially would prevent 53.7 percent of all accidents and that benefits will meet or exceed the costs if the provisions prevent 0.8 percent or more of these accidents. Table 26 shows that, after adjusting for baseline compliance, benefits will meet or exceed the costs if the training provisions prevent 14.7 percent or more of these accidents. OSHA believes that it is reasonably likely the benefits will exceed the costs because training is essential to assure that employees can follow the other provisions of the standard and because of the relatively large portion of total accidents related to this provision (53.7 percent) and the relatively low percentage of these accidents (14.7 percent) that the new provisions would need to prevent for benefits to equal costs.

5. Methodology for Comparing the Costs of Preventing Accidents, by Accident Category, to the Associated Benefits

In the first sensitivity analysis, discussed previously, OSHA determined the frequency with which each single provision would have to prevent accidents addressed by that provision for benefits to exceed costs for that provision; however, the analysis ignored the possibility that it may take multiple provisions to prevent a given accident and that not all provisions may be necessary to prevent every accident. The second sensitivity analysis, described in this section, addresses the joint effects arising from various provisions.

The requirements in the final rule work in combination to prevent accidents. For example, as noted previously, the minimum approach-distance requirements work in combination with the training requirements to prevent employees from coming too close to live parts and receiving an electric shock. OSHA took steps to assure that its provision-by-provision analysis accurately accounts for the issue of joint costs, as described later.

As noted earlier, Table 24 shows, for different categories of provisions, the number of accidents that the requirements in that category are likely to prevent. Table 27 breaks down the data in Table 24 further, and presents, for five different categories of accidents (falls from aerial lifts; falls from structures; electric shock, too close to live parts; burns from arc flash; and accidents other than those listed above), the number and percentage of accidents in each accident category that the different combinations of provisions (that is, "provision categories") in Table 24 are likely to prevent. An example illustrates how OSHA calculated the percentages in Table 27. From Table 24, the Agency determined that the information-transfer provisions in the final rule would address 77 accidents. Table 27 shows the number of those 77 accidents in each accident category, and the corresponding percentage of those 77 accidents, that the information-transfer provisions will address: Electric shock, too close to live parts—53 (69 percent); burns from arc flash—13 (17 percent); and accidents other than those listed above—11 (14 percent).

Table 28 presents the data in Table 24 differently. Specifically, Table 28 presents, for each of the five provision categories, the number and percentage of accidents (out of the total accidents reviewed by OSHA for this supplemental analysis) that each provision category of the final rule would address. Four of the categories of accidents

in Table 28 (falls from aerial lifts; falls from structures; electric shock, too close to live parts; burns from arc flash) contain numbers of accidents that are identical to the numbers contained in Table 24, as OSHA based both tables on its analysis of the CONSAD accident data. For reasons explained later, OSHA derived the number of accidents associated with the fifth category by determining the number of accidents in Table 24 that the information-transfer, job-briefing, and training provisions of the final rule could prevent, not including accidents that the provisions of the final rule that address the first four accident categories in Table 27 also could prevent. Based on the analysis in Table 27, OSHA determined that the final rule could potentially prevent 165 (or 61.6 percent) of the 268 total accidents the Agency analyzed.

Table 29 takes the analyses from Table 24, Table 27, and Table 28 and performs a sensitivity analysis that accounts for the combinations of provisions that are necessary to prevent different kinds of accidents. OSHA discusses this analysis in more detail later. However, OSHA first describes the costs associated with each accident category in detail.

For the purposes of Table 29, OSHA allocated to each hazard the costs of a provision based on the percentage of accidents addressed by the provision as a percentage of all accidents addressed by that provision. That is, if a provision has costs of $10 million dollars and 10 percent of all accidents addressed by the provision address electric-shock hazards, then OSHA allocated $1 million dollars of the costs of the provision to electric-shock hazards. OSHA believes that allocating costs of provisions in proportion to the percentage of accidents those provisions address allows for a reasonable determination of the costs of provisions associated with individual accidents. Indeed, this approach is entirely consistent with the approach OSHA takes in the final rule: For example, final §§ 1910.269(a)(2)(i)(C) and 1926.950(b)(1)(iii) specifically require that employers determine the degree of employee training based on the risk to the employees for the hazards they are likely to encounter. Accordingly, allocating costs in proportion to the percentage of accidents caused by each hazard is a reasonable approach.

There are two possibilities with respect to the costs of the provisions that address multiple kinds of hazards (like the job-briefing and information-transfer provisions). First, there may be a certain minimum time necessary for such activities as job briefings or information transfer whenever the final rule requires those activities. If so, the allocation of the minimum time for each activity is a classic joint-cost allocation problem and allocating cost as a percentage of expected benefits is one common solution. Alternatively, the total time allotted may be a function of whether or not hazards are present. If this is the case, then the percentage of accidents associated with a given hazard is a reasonable proxy for the percentage of time employees encounter the hazard and the time required to transfer the associated information. OSHA believes the data supports the conclusion that the time allotted is a function of whether or not hazards are present. For example, OSHA expects, and the data supports the conclusion, that the hazards from falls from aerial lifts and from structures will seldom be part of the information employers provide for job briefings and information transfer because employees encounter the hazards from falls from aerial lifts and from structures far less often than they do other hazards addressed by the final rule, such as electric-shock and arc-flash hazards.

Falls From Aerial Lifts

As explained later in the FEA, OSHA estimated the costs of purchasing new fall protection equipment for employees working from aerial lifts. However, this is not the only cost associated with preventing these employees from falling. To ensure that employees use this fall protection equipment properly, employers must train workers in its use. Thus, training, and, consequently, a portion of the training costs, contributes to the prevention of falls from aerial lifts. OSHA assigned a percentage (2 percent) of the annualized general training costs equal to the percentage of accidents involving such falls taken from Table 27 and added that cost to the annualized costs associated with providing fall protection for employees working from aerial lifts. The Agency estimates that the information-transfer and job-briefing requirements do not contribute substantially to the prevention of these accidents because there is little or no additional related information provided to employees as a result of those new provisions.

Falls From Structures

As explained later in the FEA, OSHA estimated the costs directly associated with the new fall-protection requirements for employees climbing or changing location on poles, towers, or similar structures. The costs include the purchase of upgraded fall protection equipment, training workers in its use, and, to a small extent (1 percent, from Table 27), job briefing. As opposed to other categories of training, the FEA includes a separate cost item for training when the employer requires workers to use the upgraded fall protection equipment. OSHA included this cost in its cost estimate for this analysis. OSHA estimated that 1 percent of the annualized job-briefing-related accidents [533] involve the "Falls from Structure" category.

Electric Shock, Too Close to Live Parts

As explained later in the FEA, OSHA estimated the costs of the revised minimum approach distances. However, the final rule further prevents electric-shock accidents involving employees approaching too close to energized parts through the revised work-positioning requirements. Employers incur costs for these requirements through training, including training in the revised minimum approach distances. Consequently, the Agency assigned a percentage of the annualized general-training costs (71 percent) to the prevention of these electric-shock accidents and added these costs to its cost estimate for the approach-distance requirements. In addition, without knowledge of the voltages of exposed live parts in the work area, employees would not be able to comply with the revised approach-distance provisions. As a result, the information-transfer (for contract employers) and job-briefing provisions also act to prevent these electric-shock accidents, and OSHA added a percentage of the annualized information-transfer and job-briefing costs (69 percent and 63 percent, respectively) to its estimated costs for the approach-distance provisions.

Burns From Arc Flash

As explained later in the FEA, OSHA estimated costs associated with the arc-flash requirements in the final rule. To follow the new work practices involving arc-flash protection, employees must receive training, and employers incur training costs associated with these requirements, in addition to the direct costs associated with these requirements. Finally, without knowledge of the estimated incident energy (or, for contract employers, the system parameters necessary to estimate incident energy), contract employers and employees would not be able to select the appropriate protective equipment. For these reasons, OSHA added a percentage of the annualized costs associated with general training (27 percent), information transfer (17 percent), and job briefing (27 percent) to its estimate of costs for the arc-flash requirements.

Accidents Other Than Those Listed Above

As shown in Table 27, the new information-transfer requirements and the new job-briefing requirements potentially could prevent 11 and 14 accidents, respectively (not including accidents in the other four accident categories).[534] The information provided to employees through these requirements would facilitate employee compliance with the work practices required by the existing standard. Therefore, the only costs of the final rule directed toward the prevention of these accidents are costs associated with the information-transfer and job-briefing provisions.

6. Sensitivity of Net Benefits to Potential Preventability

Table 29 shows the break-even percentages by type of accident and for the final rule as whole. In this analysis, OSHA first addresses the reasonableness of concluding that the

[533] The percentages listed in this portion of the analysis come from Table 27.

[534] Because the final rule effectively requires a contract employer to pass information from the host employer to the employee in charge, the job-briefing requirements in the final rule also could prevent all 11 accidents potentially prevented by the information-transfer requirements. For example, in several cases, the accidents involved employees who fell when a utility pole broke. If the host employer had information about the condition of the poles, the final rule requires the host employer to provide that information to a contract employer and, through the employees' employer, to the employee in charge. The employees then would use that information in the evaluation of the need for bracing or support as required by final §§ 1910.269(q)(1)(i) and 1926.964(a)(2).

benefits of the final rule's provisions addressing each individual type of accident outweigh the costs of those provisions. OSHA then explains how the two sensitivity analyses it conducted (that is, the first analysis showing the break-even point for each provision separately and the second analysis, discussed herein, showing the break-even point for the combined provisions) further supports the conclusion OSHA drew, in its main benefits analysis, that the total benefits of the final rule exceed the total costs of the final rule.

Table 29 indicates that, for four categories of hazards, less than 10 percent of potential benefits are necessary for benefits to break even with the costs of the provisions addressing those hazards. One category of hazard in Table 29, arc-flash-related accidents, has a breakeven effectiveness of 23.8 percent. OSHA concludes that the benefits of the final rule's provisions addressing these five categories of hazards will outweigh the costs of these provisions. First, as explained earlier, in discussing the first sensitivity analysis, if there is full compliance with all provisions necessary to protect against arc-flash, electric-shock, and climbing fall protection-related accidents (including the relevant work-practice and training, information-transfer, and job-briefing provisions), then there will be no fatalities and few or no serious injuries involving arc flash, electric shock, and climbing fall protection. Second, the break-even percentage associated with the aerial-lift fall-protection hazard is only 2.3 percent of relevant benefits (or 2.3 percent of 0.8 fatalities and 4.9 serious injuries). The new aerial-lift fall-protection provision should prevent at least this small percentage of fatalities and serious injuries. As discussed in the first sensitivity analysis, using body harnesses instead of body belts will not only reduce the number of fatalities and the severity of some injuries, but also increase the probability that employees use fall protection because it is not always possible for an employer to detect from the ground whether an employee is wearing a body belt, but it is relatively easy to determine whether an employee is wearing a body harness. Finally, the relevant benefits of the job-briefing and information-transfer provisions outweigh the costs assigned to the "other" category (which has a break-even percentage of 8.9 percent of 3.8 fatalities and 23.1 serious injuries). The relevant benefits should prevent at least this small percentage of fatalities and serious injuries. The accidents associated with the "other" category all involved employer failure to comply with the work practices required by the existing standard. As explained earlier, the information provided to employees through the new job-briefing and information-transfer requirements will facilitate employee compliance with these existing work-practice requirements. OSHA concludes that the relevant benefits will outweigh the relevant costs because of greater compliance with existing rules that the costs will engender.

Finally, the two sensitivity analyses OSHA conducted support the conclusion that, given full compliance with the final rule, the total benefits of the final rule exceed the total costs of the rule. The single-provision analysis, in Table 25 and Table 26, established the break-even percentages that are necessary for the benefits of single provisions to meet or exceed costs. In discussing that analysis, OSHA explained that it was reasonable to conclude, for each of the provisions, that benefits meet or exceed costs. Since it is reasonable to conclude, with respect to individual provisions, that benefits meet or exceed costs, it also is reasonable to conclude, based on this analysis, that the total benefits of the final rule meet or exceed total costs.

It is also reasonable to conclude, based on the second sensitivity analysis, that the total benefits of the final rule meet or exceed total costs. Table 29 provides that the final rule will have total benefits at least equal to total costs if the rule prevents 12.0 percent or more of potentially preventable accidents. Thus, according to Table 29, the final rule will have benefits that are equal to or exceed costs if the rule prevents at least 5.5 fatalities and 33 injuries per year (that is, 12.0 percent of the 45.5 total fatalities and 273.1 total injuries potentially prevented annually by the final rule).[535] Full compliance with the final rule will almost certainly prevent 12.0 percent or more of potentially preventable accidents because, as explained in the discussion of the first sensitivity analysis, fatalities and serious injuries from climbing fall protection, minimum approach-distance, and arc-flash-related accidents are virtually impossible if there is full compliance with the final rule. According to Table 29, these hazards together account for 55.2 percent of all accidents OSHA reviewed for this supplemental analysis, as well as 40.8 fatalities and 245.1 injuries.

Accident category	Provision category							
	Information transfer		Job briefing		Training other than fall protection for structures*		Training in fall protection for structures*	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Falls from Aerial Lifts	0	0	0	0	3	2	N/A	N/A
Falls from Structures	0	0	1	1	N/A	N/A	10	100
Electric Shock, Too Close to Live Parts	53	69	96	63	95	71	N/A	N/A
Burns from Arc Flash	13	17	42	27	36	27	N/A	N/A
Accidents Other than Those Listed Above	11	14	14	9	0	0	N/A	N/A
Total	77	100	153	100	134	100	10	100

Accident category	Provision category							
	Aerial lift fall protection		Climbing fall protection		Approach distance		Arc flash	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Falls from Aerial Lifts	3	100	.....	.....	.....	.....	.....	.....
Falls from Structures	.....	.....	10	100	.....	.....	.....	.....
Electric Shock, Too Close to Live Parts	.....	.....	.....	.....	96	100	.....	.....
Burns from Arc Flash	.....	.....	.....	.....	.....	.....	42	100
Accidents Other than Those Listed Above	.....	.....	.....	.....	.....	.....	.....	.....
Total	.....	.....	.....	.....	.....	.....	.....	.....

*The FEA separately estimates costs for training employees in upgraded fall protection for poles, towers, or similar structures.

[535] The 45.5 total potentially prevented annual fatalities and 273.1 total potentially prevented annual injuries are the sums of the fatalities and injuries potentially prevented annually for each accident type, from columns 3 and 4 in Table 29.

TABLE 28—ACCIDENT CATEGORIES AND TOTAL NUMBER AND PERCENT OF ACCIDENTS POTENTIALLY PREVENTED BY ALL PROVISIONS

Accident category	Number*	Percent†
Falls from Aerial Lifts	3	1.1
Falls from Structures	10	3.7
Electric Shock, Too Close to Live Parts	96	35.8
Burns from Arc Flash	42	15.7
Accidents Other than Those Listed Above	14	5.2
Total	165	61.6

*Number of accidents addressed by the final rule.
†Percent of 268 total accidents.

TABLE 29—THE BENEFITS AND COSTS OF PROVISIONS OF THE ELECTRIC POWER GENERATION STANDARD COMPARED, BY TYPE OF ACCIDENT

Type of accident/relevant provisions	Percent of relevant accidents addressed by provisions (from Table 28)	Fatalities potentially prevented annually*	Injuries potentially prevented annually†	Total potential annual monetized benefits‡	Aggregate annualized cost of provisions (from FEA)	Portion of relevant accidents related to particular provision§	Annualized cost of preventing particular hazard	Percentage of potential benefits needed to break even with costs**
Aerial Lift Fall Protection:								
Equipment					$113,222	1	$113,222	
Training					2,950,935	0.02	59,019	
SUBTOTAL	1.1	0.8	4.9	$7,384,608			172,241	2.3
Climbing Fall Protection:								
Equipment					451,768	1	451,768	
Training††					68,719	1	68,719	
Job Briefing					6,697,557	0.01	66,976	
SUBTOTAL	3.7	2.7	16.4	24,839,136			587,463	2.4
MAD:								
Evaluation/Equipment					1,807,505	1	1,807,505	
Training					2,950,935	0.71	2,095,164	
Information Transfer					17,820,841	0.69	12,296,380	
Job Briefing					6,697,557	0.63	4,219,461	
SUBTOTAL	35.8	26.5	159.0	240,335,424			20,418,510	8.5
Arc-Flash Protection:								
Evaluation/Equipment					19,446,147	1	19,446,147	
Training					2,950,935	0.27	796,753	
Information Transfer					17,820,841	0.17	3,029,543	
Job Briefing					6,697,557	0.27	1,808,341	
SUBTOTAL	15.7	11.6	69.7	105,398,496			25,080,783	23.8
Other:								
Information Transfer					17,820,841	0.14	2,494,918	
Job Briefing					6,697,557	0.09	602,780	
SUBTOTAL	5.2	3.8	23.1	34,909,056			3,097,698	8.9
TOTAL	61.5	45.5	273.1	412,866,720			49,356,694	12.0

*Percentage of accidents potentially prevented (from Table 28) multiplied by 74 (the number of fatalities of the type addressed by the final rule).
†Percentage of accidents potentially prevented (from Table 28) multiplied by 444 (the number of injuries of the type addressed by the final rule).
‡Cases valued at $8.7 million per fatality, $62,000 per injury.
§From Table 27.
**Percentage of Potential Benefits Needed to Break Even with Costs derived by dividing the costs in column 8 by the benefits in column 5.
††In the FEA, OSHA separately estimated costs associated with training employees on the revised fall-protection requirements for climbing and changing location on poles, towers, and similar structures.
Note: Totals may not equal the sum or product of the components due to rounding.

F. Technological Feasibility

In accordance with the OSH Act, OSHA must demonstrate that occupational safety and health standards promulgated by the Agency are technologically feasible. OSHA demonstrates that a standard is technologically feasible "by pointing to technology that is either already in use or has been conceived and is reasonably capable of experimental refinement and distribution within the standard's deadlines" (*American Iron and Steel Inst.* v. *OSHA*, 939 F.2d 975, 980 (D.C. Cir. 1991) (*per curiam*) (internal citation omitted)). OSHA reviewed each of the requirements imposed by the final rule and determined that compliance with the requirements of the rule is technologically feasible for all affected industries, that employers can achieve compliance with all of the final requirements using readily and widely available technologies, and that there are no technological constraints associated with compliance with any of the final requirements.

The final rule in Subpart V and § 1910.269 includes several new provisions or requirements that differ from the proposed rule. These modifications primarily involve personnel time to develop programs and

procedures and to train employees. Any equipment required to comply is either currently in use or readily available. OSHA determined, based on its review, that all of the work practices and specifications required by the final standard are consistent with equipment procurement, installation, and work practices widely accepted in these industries.

Several factors support OSHA's determination regarding the technological feasibility of the final rule. First, OSHA concluded that compliance with existing § 1910.137 and § 1910.269 was technologically feasible when it promulgated those standards in 1994 (59 FR 4431). OSHA carefully reviewed the application of these provisions to construction operations and determined that the provisions in the final rule that OSHA based on the existing standards are technologically feasible in these operations. In fact, OSHA estimated as part of its cost analysis that 95 percent of firms that perform work for the construction of electric power transmission and distribution lines and equipment are currently following these standards because the firms also perform repair and maintenance work subject to § 1910.269.

Second, the provisions in the standard not based on existing standards are also technologically feasible. As is evident from the discussion of § 1926.960(g)(2) in Section V, Summary and Explanation of the Final Rule, earlier in this preamble, any software that employers might have to use to comply with the final arc-hazard assessment provision is readily and widely available. Moreover, as is evident from the compliance-rate data discussed in this section of the preamble, the arc-flash protective equipment required by the final rule is readily and widely available, and the harnesses and work-positioning equipment required by the final rule are also readily and widely available.[536]

Third, OSHA based many of the provisions in the final rule on national consensus standards, or indicated in the regulatory text of the final rule that it would deem employers that comply with specific provisions of certain national consensus standards to be in compliance with specified provisions of the final rule. Reliance on a national consensus standard provides assurance that a broad consensus of industry representatives recognize that a means of compliance is an appropriate way to comply and is, therefore, technologically feasible.

Fourth, in Section V, Summary and Explanation of the Final Rule, earlier in this preamble, OSHA adequately responded to issues associated with the technological feasibility of specific provisions. In that section of the preamble, OSHA discussed technological feasibility concerns raised by rulemaking participants and also discussed the technological feasibility of provisions that differ from the proposed rule (such as the changes to the fall protection and minimum approach-distance requirements). The legal test for proving technological feasibility requires OSHA to establish a "reasonable possibility that the typical firm will be able to . . . meet the [standard's requirement] in most of its operations" (*American Iron and Steel Inst.* v. *OSHA*, 939 F.2d 975, 980 (D.C. Cir. 1991) (*per curiam*) (internal citation omitted)). The following examples demonstrate how OSHA satisfied this test with respect to the key minimum approach distance and fall protection provisions.

In the section addressing OSHA's revision of the minimum approach-distance requirements, OSHA addressed concerns that not all systems have the space necessary to accommodate the larger minimum approach distances that may result when an employer uses the final rule's new default values for maximum per-unit transient overvoltages. (See the discussion of § 1926.960(c)(1).) Instead of using these default values, employers may use an engineering analysis to determine the actual values for maximum per-unit transient overvoltages and then apply these values when calculating the required minimum approach distances. However, even then it is possible for the transient overvoltages to result in a minimum approach distance that exceeds the available space. In such cases, employers have the option of reducing the maximum transient overvoltages by implementing such measures as portable protective gaps, portable lightning arresters, circuit alterations, or operational controls (including disabling the automatic reclosing feature on the circuit and restricting circuit switching). Finally, if employers cannot use any of these measures to reduce the maximum transient overvoltages and, thereby, lessen the minimum approach distances, they have the option of deenergizing the circuit to perform the work. Therefore, the final rule's minimum approach-distance requirements will not prevent employers from completing their work.

With respect to the final rule's requirement that qualified employees use fall protection when climbing and changing location on poles, towers, or similar structures, OSHA concluded, based on the record, that under these conditions it is generally feasible for employees to climb and change location while using fall protection. (See the discussion of § 1926.954(b)(3)(iii).) Substantial evidence in the record supports OSHA's determination that the final rule is technologically feasible, notwithstanding the Agency's acknowledgment in Section V, Summary and Explanation of the Final Rule, earlier in this preamble, that there may be limited circumstances that preclude the use of fall protection while qualified employees are climbing, or changing location on, a structure. OSHA addressed this issue by incorporating into the final standard an exception to the requirement for fall protection under these circumstances. Accordingly, the final rule provides that qualified employees need not use fall protection when climbing or changing location on poles, towers, or similar structures if 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. (See § 1926.954(b)(3)(iii)(C).)

G. Costs of Compliance

1. Introduction

This portion of the analysis presents the estimated costs of compliance for the final rule. The estimated costs of compliance represent the additional costs necessary for employers to achieve full compliance. They do not include costs for employers that are already complying with the new requirements, nor do they include costs associated with achieving full compliance with existing applicable requirements.

This analysis includes all elements of the final rulemaking, including changes to 29 CFR Part 1910 and 29 CFR Part 1926. OSHA analyzed this consolidated set of actions in its entirety and included only parts of the final rule identified as imposing more than negligible costs in the analysis of compliance costs and impacts. The provisions of the rule with costs accounted for in this section include:

- Paragraph (b)(1) of § 1926.950 and § 1910.269(a)(2)(i) require each employee to receive training in, and to be familiar with, the safety-related work practices, safety procedures, and other safety requirements that pertain to his or her respective job assignments, as well as applicable emergency procedures.

[536] For voltages of 50 to 300 volts, Table R–3 specifies a minimum approach distance of "avoid contact." The minimum approach distance for this voltage range contains neither an electrical component nor an ergonomic component.

Table 30 refers to the nonnegligible costs of these provisions as "Training."

• Paragraph (c) of § 1926.950 and § 1910.269(a)(3) require host employers to provide certain information to contract employers, contract employers to provide certain information to host employers, and some coordination between host employers and contract employers. Table 30 refers to the nonnegligible costs of these provisions as "Host-contractor communication."

• Paragraph (a)(1) of § 1926.952 and § 1910.269(c)(1)(i) require the employer to provide the employee in charge of the job with all available information that relates to the determination of existing characteristics and conditions that the crew must complete. Table 30 refers to the nonnegligible costs of these provisions as "Job briefing."

• Paragraph (b)(3)(iii)(A) of § 1926.954 and § 1910.269(g)(2)(iv)(C)(*1*) require that employees working in aerial lifts use appropriate fall protection. Table 30 refers to the nonnegligible costs of these provisions as "Use of harnesses in aerial lifts."

• Paragraphs (b)(3)(iii)(B) and (b)(3)(iii)(C) of § 1926.954 and § 1910.269(g)(2)(iv)(C)(*2*) and (g)(2)(iv)(C)(*3*) require employees climbing or changing work locations at elevated locations more than 1.2 meters (4 feet) above the ground on poles, towers, or similar structures to use appropriate fall protection. Table 30 refers to the nonnegligible costs of these provisions as "Upgrading fall protection equipment."

• Paragraph (c)(1) of § 1926.960 and § 1910.269(l)(3) require the employer to establish minimum approach distances and to ensure that no employee approaches or takes any conductive object closer to exposed energized parts than the established MAD, unless they use certain, specified safe work practices. Table 30 refers to the nonnegligible costs of these provisions as "MAD."

• Paragraph (g)(1) of § 1926.960 and § 1910.269(l)(8)(i) require employers to perform a hazard assessment to determine if each employee would be exposed to hazards from flames or from electric arcs. For employees exposed to such hazards, §§ 1926.960(g)(2) and 1910.269(l)(8)(ii) require the employer to make a reasonable estimate of the incident heat energy of each such exposure. Table 30 refers to the nonnegligible costs of these provisions as "Arc-hazard assessment."

• Paragraphs (g)(4) and (g)(5) of § 1926.960 and § 1910.269(l)(8)(iv) and (l)(8)(v) require the employer to select, and ensure that employees use, appropriate flame-resistant and arc-rated clothing and equipment (collectively referred to as arc-flash protective equipment). Table 30 refers to the nonnegligible costs of these provisions as "Provision of appropriate arc-flash protective equipment."

Table 30 presents the total annualized estimated costs by provision and by industry sector.

TABLE 30—SUMMARY OF COMPLIANCE COST BY INDUSTRY AND PROVISION

Industry code	Industry name	Training	Host-contractor communication	Job briefing	Other costs for employees not already covered by § 1910.269	Calculating incident energy and arc-hazard assessment (arc-hazard assessment)
NAICS 234910	Water, Sewer, and Pipeline Construction.	$59,908	$150,214	$70,743	$4,427	NA
NAICS 234920	Power and Communication Transmission Line Construction.	1,579,831	1,891,463	1,777,657	121,855	NA
NAICS 234930	Industrial Nonbuilding Structure Construction.	3,216	204,286	70,999	NA	NA
NAICS 234990	All Other Heavy Construction	317,634	894,356	424,921	25,941	NA
NAICS 235310	Electrical Contractors	840,667	2,702,235	1,545,162	76,067	NA
NAICS 235910	Structural Steel Erection Contractors	5,642	47,763	24,717	NA	NA
NAICS 235950	Building Equipment and Other Machine Installation Contractors.	8,134	44,957	23,197	NA	NA
NAICS 235990	All Other Special Trade Contractors	23,289	124,535	71,957	NA	NA
NAICS 221110	Electric Power Generation	29,583	2,397,541	675,284	NA	$628,793
NAICS 221120	Electric Power Transmission, Control, and Distribution.	54,588	6,393,786	1,144,815	NA	1,012,130
NAICS 2211	Major Publicly Owned Utilities	7,345	571,626	153,887	NA	261,913
Various	Industrial Power Generators	4,778	648,391	306,992	NA	284,046
SIC 0783	Ornamental Shrub and Tree Services.	16,321	1,749,688	407,227	NA	NA
Total		2,950,935	17,820,841	6,697,557	228,289	2,186,883

Industry code	Industry name	Provision of appropriate arc-flash protective equipment	Use of harnesses in aerial lifts	Upgrading fall protection equipment	MAD	Total annualized compliance costs
NAICS 234910	Water, Sewer, and Pipeline Construction.	$180,982	NA	NA	NA	$466,274
NAICS 234920	Power and Communication Transmission Line Construction.	5,051,365	NA	$108,190	NA	10,530,361
NAICS 234930	Industrial Nonbuilding Structure Construction.	216,963	NA	NA	NA	495,465
NAICS 234990	All Other Heavy Construction	1,141,710	NA	NA	NA	2,804,561
NAICS 235310	Electrical Contractors	3,468,183	NA	NA	NA	8,632,314
NAICS 235910	Structural Steel Erection Contractors	58,585	NA	NA	NA	136,706

Industry code	Industry name	Provision of appropriate arc-flash protective equipment	Use of harnesses in aerial lifts	Upgrading fall protection equipment	MAD	Total annualized compliance costs
NAICS 235950	Building Equipment and Other Machine Installation Contractors.	54,894	NA	NA	NA	131,182
NAICS 235990	All Other Special Trade Contractors	174,370	NA	NA	NA	394,151
NAICS 221110	Electric Power Generation	2,084,506	NA	116,972	NA	5,932,679
NAICS 221120	Electric Power Transmission, Control, and Distribution.	3,546,921	NA	199,879	$1,593,692	13,945,811
NAICS 2211	Major Publicly Owned Utilities	475,610	NA	26,727	213,812	1,710,921
Various	Industrial Power Generators	805,175	$48,612	NA	NA	2,097,993
SIC 0783	Ornamental Shrub and Tree Services.	0	64,610	NA	NA	2,237,846
Total	.....	17,259,264	113,222	451,768	1,807,505	49,516,264

Note: (1) Totals may not equal the sum of the components due to rounding.
(2) "NA" = Not Applicable.
Sources: Office of Regulatory Analysis, OSHA. See text.

As shown in Table 30, OSHA estimated the total annualized cost of compliance with the final rule to be about $49.5 million. The largest component of the compliance costs, at approximately $17.3 million annually, is the cost of providing arc-flash protective equipment. The other provisions of the final rule resulting in nonnegligible compliance costs include training ($3.0 million), host-contractor communication ($17.8 million), job briefing ($6.7 million), calculating incident energy and arc-hazard assessment (arc-hazard assessment) ($2.2 million), use of harnesses in aerial lifts ($0.1 million), upgrading fall protection equipment ($0.5 million), and MAD ($1.8 million). In addition, the Agency estimated other minor costs for employees potentially not covered by existing § 1910.269 ($0.2 million).

The remainder of this portion of the analysis explains the details underlying the calculations of the compliance costs associated with the final rule. OSHA estimated compliance costs for each provision of the rule that involves nonnegligible costs and for each affected industry sector. OSHA calculated total annualized costs by annualizing nonrecurring one-time costs (at 7 percent over 10 years) and then adding these costs to recurring annual costs.[536] The calculations of the estimated costs associated with compliance are representative of the average resources necessary to achieve compliance with the final rule.

OSHA based labor costs on industry-specific wage rates published by BLS [37], then, using data from its National Compensation Survey, OSHA adjusted those rates upwards by 43.5 percent to account for benefits and other employee-related costs [36], as presented in Table 31.[537] OSHA estimated supervisory wage rates, including benefits, to be $29.20 per hour in the Ornamental Shrub and Tree Services industry, with an estimated range of $41.55 to $50.60 in all other affected industries. The Agency estimated electric power worker wage rates, including benefits, to be $21.26 per hour in the Ornamental Shrub and Tree Services industry, with an estimated range of $29.99 to $40.77 in all other affected industries. OSHA estimated wage rates for engineers in the electric utility industry, including benefits, to be $51.94 per hour. The Agency estimated clerical wage rates, including benefits, to be $20.27 per hour in the Ornamental Shrub and Tree Services industry, with an estimated range of $22.44 to $28.75 in all other affected industries.

The appropriate sections of this analysis address the comments on the costs of specific provisions of the final rule. For other provisions, OSHA adhered to the general approach it adopted in the PRIA. In most cases, commenters did not question the cost methodology used in the PRIA; therefore, OSHA carried this methodology over to this FEA. OSHA notes that, unless otherwise indicated, any increase in cost in the FEA above the costs in the PRIA is due to market factors, such as inflation and an increase in employment or number of projects in the relevant industries.

TABLE 31—SUMMARY OF WAGE RATES FOR CALCULATING COMPLIANCE COSTS, BY INDUSTRY

Industry code	Industry name	Supervisor	Clerical	Electric power worker*	Utility supervisor	Utility engineer	Health and safety specialist	Consultant
NAICS 234910 ..	Water, Sewer, and Pipeline Construction.	$42.35	$23.76	$34.55	NA	NA	NA	NA
NAICS 234920 ..	Power and Communication Transmission Line Construction.	42.35	23.76	34.55	NA	NA	NA	NA

[536] OSHA annualized one-time costs using the formula $C_t = Ci(1+i)^t/(1+i)^t - 1$, where C is the total one-time cost (also referred to as the "Present Value"), i is the interest rate, and t is the number of years over which the cost is annualized (for example, the life of equipment). Loan-payment formulas, which can be used to calculate annualized payments for one-time costs, are standard items in spreadsheet software. To use these formulas to calculate annualized costs, substitute the annualization interest rate for the interest rate on the loan, the number of years of annualization for the loan period, and the one-time cost for the present value of the loan (the amount borrowed).

[537] The survey indicated the benefits component to be 30.3 percent of total compensation, the remainder being wages. The adjustment represents wages × (30.3/69.7). As elsewhere in the analysis, OSHA has performed its calculation on the precise fraction.

TABLE 31—SUMMARY OF WAGE RATES FOR CALCULATING COMPLIANCE COSTS, BY INDUSTRY—Continued

Industry code	Industry name	Supervisor	Clerical	Electric power worker*	Utility supervisor	Utility engineer	Health and safety specialist	Consultant
NAICS 234930 ..	Industrial Nonbuilding Structure Construction.	42.30	24.46	34.55	NA	NA	NA	NA
NAICS 234990 ..	All Other Heavy Construction	41.81	23.60	29.99	NA	NA	NA	NA
NAICS 235310 ..	Electrical Contractors	42.47	23.10	37.49	NA	NA	NA	NA
NAICS 235910 ..	Structural Steel Erection Contractors.	42.27	22.44	37.49	NA	NA	NA	NA
NAICS 235950 ..	Building Equipment and Other Machine Installation Contractors.	42.47	23.10	37.49	NA	NA	NA	NA
NAICS 235990 ..	All Other Special Trade Contractors.	41.55	23.13	30.72	NA	NA	NA	NA
NAICS 221110 ..	Electric Power Generation	50.60	28.75	40.77	$50.60	$51.94	$50.79	$250.00
NAICS 221120 ..	Electric Power Transmission, Control, and Distribution.	50.60	28.75	40.77	50.60	51.94	NA	250.00
NAICS 2211	Major Publicly Owned Utilities	50.60	28.75	40.77	50.60	51.94	NA	250.00
Various	Industrial Power Generators	50.60	28.75	40.77	50.60	51.94	NA	250.00
SIC 0783	Ornamental Shrub and Tree Services.	29.20	20.27	21.26	NA	NA	NA	NA

*Depending upon the industry and the type of work performed (that is, power generation, power line, or both), these workers include line workers, tree-trimming crew members, power plant workers, and substation workers.

Notes: (1) Wage rates include an additional 30.3 percent of base salary for fringe-benefit costs.
(2) "NA" = Not Applicable.
Sources: BLS [36, 37].

For most provisions of the final rule, OSHA based the cost estimate in part on the estimated percentage of workers or firms already in compliance with the rule's requirements. OSHA originally drew the compliance rates used to calculate costs from CONSAD's report in support of the PRIA [5], which commenters on the proposal did not question, except as noted. In most cases, CONSAD estimated different compliance rates for small unionized establishments, small nonunionized establishments, large unionized establishments, and large nonunionized establishments.[538] There are a few exceptions: Major Publicly Owned Utilities (NAICS 2211) and Ornamental Shrub and Tree Services (SIC 0783) only have compliance-rate estimates for small and large establishments, and Industrial Power Generators only have a compliance-rate estimate for large establishments. Generally, following the findings of CONSAD's report [5], OSHA estimated that larger establishments and unionized workforces have higher compliance rates than smaller establishments and nonunionized establishments. The compliance cost tables presented later in this section of the preamble list these compliance rates as appropriate.

One-Time Costs for Revising Training Programs

Establishments covered by this final rule may need to revise their existing training programs to accommodate the amendments to existing standards made in this final rule. For example, employers may need to revise their training programs to address revisions in the employers' minimum approach distances or arc-flash protection practices. However, these costs are one-time costs only because employers will have to revise these training programs once. These costs, therefore, merely reflect the transitional costs of the new standard.

For all industries except for Ornamental Shrub and Tree Services, OSHA estimated the costs associated with revising training programs based on 8 hours of supervisory time plus an hour of clerical time.[539] Due to the limited and less complex training required for employees in the Ornamental Shrub and Tree Services industry, OSHA estimated the costs associated with revising a training program in this industry based on 4 hours of supervisory time plus half an hour of clerical time [5].[540]

Thus, OSHA estimates that the average cost of compliance per affected establishment for revising existing training programs will be $127 for establishments in the Ornamental Shrub and Tree Services industry and $356 to $434 per establishment in all other affected industries.

Most establishments in the affected industries either already have training programs that meet the requirements of the final rule or regularly revise their training programs to account for new information or work practices. These establishments will not incur any additional costs to achieve compliance with the final rule.

OSHA estimated rates of current compliance for each affected industry. Within each industry, the Agency estimated rates of current compliance separately for establishments based on

[538] As with other assertions in this analysis not supported directly by a citation, OSHA based its estimates on CONSAD's analysis. CONSAD based its initial estimates on information gathered from Agency stakeholder meetings held in 2000 and from site visits conducted in 2001 and 2002. These initial estimates were reviewed by small entity representatives during the SBREFA process, in accordance with the SBREFA Panel findings, as summarized in the 2003 report of the Small Business Advocacy Review Panel [29]. CONSAD subsequently modified its estimates to reflect the findings of the Panel. CONSAD also incorporated information from the regulatory analysis, and supporting research, for the 1994 § 1910.269 rulemaking and from regulatory analyses for related rulemakings. The CONSAD report was finalized in 2005 [5]. Unless otherwise specified, OSHA received no objections to, or new evidence about, CONSAD's estimates, and the estimates were not altered.

[539] One commenter suggested that it would take more than 8 hours to revise its training program (Ex. 0240). While it is possible that some larger employers with complex operations may find this to be the case, the Agency believes its estimate is a reasonable average, in part because employers already are training employees in need of training on existing § 1910.269 and, in many cases, already are operating under elements of the final standard.

[540] OSHA is retaining from the PRIA its estimate of 4 hours of supervisory time, plus a half an hour of clerical time, for the Ornamental Shrub and Tree Services industry (70 FR 34905). Although no commenter objected to the estimate in the PRIA, OSHA now believes the estimate is conservative given the limited obligations on this industry specified by the final rule.

their size and on whether they had a unionized workforce. In the Ornamental Shrub and Tree Services industry, estimated rates of current compliance range from 50 to 75 percent. In all other affected industries, OSHA estimated rates of current compliance to range from 75 to 98 percent [5].

The total estimated cost of compliance for revising training programs is $0.7 million. Annualizing this nonrecurring one-time cost at a rate of 7 percent over 10 years [541] results in a total estimated annualized cost of approximately $0.1 million for all affected industries, as shown in Table 32. Table 32 also shows the costs of compliance for each affected industry.

TABLE 32—ANNUALIZED ONE-TIME COSTS FOR REVISING TRAINING PROGRAMS

Industry code	Industry name	Establishments affected (%)	Average cost per affected establishment	Compliance rates (%)	Annualized one-time compliance costs
NAICS 234910	Water, Sewer, and Pipeline Construction	95	$363	90/75/95/85	$6,426
NAICS 234920	Power and Communication Transmission Line Construction.	95	363	90/75/95/85	21,836
NAICS 234930	Industrial Nonbuilding Structure Construction.	100	363	90/75/95/85	1,804
NAICS 234990	All Other Heavy Construction	95	358	90/75/95/85	5,233
NAICS 235310	Electrical Contractors	95	363	90/75/95/85	13,158
NAICS 235910	Structural Steel Erection Contractors	100	361	90/75/95/85	5,258
NAICS 235950	Building Equipment and Other Machine Installation Contractors.	100	363	90/75/95/85	7,774
NAICS 235990	All Other Special Trade Contractors	100	356	90/75/95/85	22,351
NAICS 221110	Electric Power Generation	100	434	95/95/98/98	3,325
NAICS 221120	Electric Power Transmission, Control, and Distribution.	100	434	95/95/98/98	9,821
NAICS 2211	Major Publicly Owned Utilities	100	434	95/98	1,350
Various	Industrial Power Generators	100	434	98	1,127
SIC 0783	Ornamental Shrub and Tree Services	100	127	50/75	2,130
Total					101,592

Notes: (1) Totals may not equal the sum of the components due to rounding.
(2) For most NAICSs, compliance rates are for small unionized establishments, small nonunionized establishments, large unionized establishments, and large nonunionized establishments, respectively. Major Publicly Owned Utilities (NAICS 2211) and Ornamental Shrub and Tree Services (SIC 0783) only have compliance rates for small and large establishments, and Industrial Power Generators only have a compliance rate for large establishments.
Sources: CONSAD [5], U.S. Census [43, 44, 45, 46].

One-Time Costs for Providing Additional Training for Employees Already Receiving Training in Accordance With Existing § 1910.269

The final rule will impose costs related to the additional training required for employees currently receiving training that complies with existing § 1910.269. The costs in this section describe the cost of performing the training once the employer redesigns the program. As discussed in greater depth elsewhere, affected firms that perform construction work typically will need to comply with requirements of § 1910.269 as their operations span both construction and general industry operations. In this regard, § 1910.269 already effectively covers these firms. The discussion under the next heading provides costs for the limited number of firms that perform only construction operations.[542]

OSHA estimates the costs associated with the additional training required for these employees as involving resources (including labor costs or other expenditures) equivalent to 1.5 hours of employee time plus 12 minutes of supervisory time plus 3 minutes of clerical time per employee for all affected industries, except Ornamental Shrub and Tree Services [5].[543] For establishments in the Ornamental Shrub and Tree Services industry, OSHA estimates that providing additional training involves resources (including labor costs or other expenditures) equivalent to 0.75 hours of employee time plus 6 minutes of supervisory time plus 3 minutes of clerical time per employee [*id.*].

OSHA estimates that the average cost of compliance for providing the additional training will be 20 per employee for establishments in the Ornamental Shrub and Tree Services industry and will range from 55 to 73 per employee in all other affected industries.

OSHA accounted for new hires using a 3- to 53-percent turnover rate, depending on the industry, and accounted for additional costs associated with the transition to the final rule in the first-year by halving the

[541] Unless otherwise discussed in this FEA, and as with most other one-time costs under the final standard, OSHA annualized costs assuming that initial costs will occur in the first year after promulgation of the standard. OSHA notes that the PRIA referred to one-time costs as first-year costs. The Agency did not annualize these costs when initially presented in the PRIA, but did annualize them in the FEA.

[542] In the proposal, OSHA also accounted for on-going, annual training costs. OSHA determined that this approach was an error. Employers providing additional training for employees already receiving training in accordance with existing § 1910.269 will not accrue new on-going training costs in conjunction with the training requirements in revised § 1910.269 because these employers already must provide training under existing § 1910.269; OSHA does not consider the modified requirements of the revised standard to be more time-intensive than the existing requirements. Any new training (including the training in the use of fall protection for qualified climbers, discussed *infra*) replaces training already required. In contrast, OSHA notes that any employers providing additional training for employees not already receiving training in accordance with existing § 1910.269 will accrue new on-going, annual training costs.

[543] Consistent with this estimate, one commenter, Siemens Power Generation, Inc., noted that its employees already receive 4—8 hours of electrical safety training per year (Ex. 0163). The commenter indicated that the additional time OSHA allotted for training was not sufficient for its workers. In response, the Agency states that the assigned 1.5 hours additional training is an average for most workers, including workers in the commenter's industry, and that the allotted time should be sufficient to address the hazards for workers in that industry. The Agency also emphasizes that this estimate covers training on the new elements of the standard, not an entire safety training course.

applicable turnover rate for each industry. OSHA notes that it increased the estimated turnover rate for Ornamental Shrub and Tree Services from 31 percent to 53 percent based on comments received from the Tree Care Industry Association (Exs. 0419, 0503). Table 33 shows the estimated turnover rates for the various affected industry segments.[544]

Based on research conducted by CONSAD, OSHA estimates that most establishments in affected industries already are providing training that fully complies with the requirements of the final rule [5]. These establishments will not incur any costs for training under the final rule.

OSHA estimated the rates of current compliance with the final requirements for each affected industry. Within each industry, the Agency estimated rates of current compliance separately for establishments based on their size and whether they have a unionized workforce. In the Ornamental Shrub and Tree Services industry, estimated rates of current compliance range from 50 to 75 percent. In all other affected industries, the estimated rates of current compliance range from 75 to 98 percent [5].

The total estimated one-time cost of compliance for providing training that meets the requirements of the final rule is 0.6 million. When OSHA annualized this nonrecurring one-time cost at a rate of 7 percent over 10 years, it results in total estimated annualized costs of approximately 0.1 million, as shown in Table 33. Table 33 also shows the costs of compliance for each affected industry.

TABLE 33—ANNUALIZED ONE-TIME COSTS FOR PROVIDING ADDITIONAL TRAINING TO EMPLOYEES ALREADY RECEIVING TRAINING IN ACCORDANCE WITH EXISTING § 1910.269

Industry code	Industry name	Employees affected (%)	Turnover rate (%)	% workers in first-year transition	Average cost per affected employee	Compliance rate (%)	Annualized one-time compliance costs
NAICS 234910	Water, Sewer, and Pipeline Construction.	95	16	8	$61	90/75/95/85	$1,082
NAICS 234920	Power and Communication Transmission Line Construction.	95	16	8	61	90/75/95/85	28,521
NAICS 234930	Industrial Nonbuilding Structure Construction.	100	16	8	62	90/75/95/85	1,413
NAICS 234990	All Other Heavy Construction	95	16	8	55	90/75/95/85	5,984
NAICS 235310	Electrical Contractors	95	11	6	66	90/75/95/85	21,348
NAICS 235910	Structural Steel Erection Contractors.	100	11	6	66	90/75/95/85	384
NAICS 235950	Building Equipment and Other Machine Installation Contractors.	100	11	6	66	90/75/95/85	360
NAICS 235990	All Other Special Trade Contractors.	100	11	6	56	90/75/95/85	938
NAICS 221110	Electric Power Generation	100	3	2	73	95/95/98/98	8,023
NAICS 221120	Electric Power Transmission, Control, and Distribution.	100	3	2	73	95/95/98/98	13,608
NAICS 2211	Major Publicly Owned Utilities	100	3	2	73	95/98	1,829
Various	Industrial Power Generators	100	3	2	73	98	3,651
SIC 0783	Ornamental Shrub and Tree Services.	100	53	27	20	50/75	14,191
Total							101,332

Notes: (1) Totals may not equal the sum of the components due to rounding.
(2) For most NAICSs, compliance rates are for small unionized establishments, small nonunionized establishments, large unionized establishments, and large nonunionized establishments, respectively. Major Publicly Owned Utilities (NAICS 2211) and Ornamental Shrub and Tree Services (SIC 0783) only have compliance rates for small and large establishments, and Industrial Power Generators only have a compliance rate for large establishments.
Sources: CONSAD [5], U.S. Census [43, 44, 45, 46].

One-Time Costs for Additional Training for Employees Not Already Receiving Training in Accordance with Existing § 1910.269

Companies that perform construction work associated with electric power generation, transmission, and distribution systems generally are also able and willing to perform (and do perform) similar work involving the repair and maintenance of such systems. The distinction between construction work and repair or maintenance work can be difficult to make in some situations. For example, the distinction may hinge on whether a particular piece of equipment is regarded as an upgrade or a "replacement-in-kind."

Since the work is often almost identical, companies are not likely to restrict themselves to only repair or maintenance work, or to only construction work, with regard to potential jobs involving electric power generation, transmission, and distribution. Thus, it is reasonable to assume that any company involved in such work will have their employees trained as required by the existing OSHA standard addressing this type of work in general industry (§ 1910.269).

Small business representatives from the affected industries providing

[544] The FEA carries over the assumption, presented in the original CONSAD analysis and carried through the PRIA, of additional one-time training costs related to turnover. OSHA received no comments on this approach. The consideration of turnover here is to account for potential transitional costs related to the incremental increase in the time it takes to train new employees. In any event, inclusion of these costs results, at most, in a more conservative (and perhaps overestimated) estimate of costs.

comments to OSHA on a draft of the proposed rule generally indicated that construction contractors follow and comply with § 1910.269 for all of their work, including construction work. But some small business representatives indicated that there are some companies that follow the existing standards for construction work in Subpart V, rather than the standards for general industry work in § 1910.269 [29].

When performing construction jobs covered by existing Subpart V, employers may be able to avoid costs associated with complying with § 1910.269 requirements unrelated to training. However, those employers would still incur training costs if they perform maintenance jobs, which are covered by existing § 1910.269. Thus, before the compliance deadlines for the final rule, compliance with the training requirements of § 1910.269 in particular is likely, even if a specific job involves only construction work and the employer follows the relevant provisions of Subpart V.

The number of firms, if any, that do only construction work as defined by OSHA, and, therefore, avoid providing a basic training regimen for employees under existing § 1910.269, is difficult to estimate. One Small Entity Representative (SER) estimated that about 10 to 30 percent of contractors involved in electric power transmission and distribution work may exclusively do construction; another representative stated that it did not know of any contractor firms that do exclusively construction work [29].

It is unlikely that contractors performing electric power generation, transmission, or distribution work meet both of the following criteria: (1) know and expect that, for all projects performed, only construction work will be done such that they do not need to train employees as required by existing § 1910.269 and (2) have employees work without providing them with what many consider to be minimum basic safety training applicable to this type of work, as specified in the training requirements in existing § 1910.269. Only contractors meeting both of these criteria will incur costs under the final rule for training employees who are not already receiving training in accordance with existing § 1910.269.

In the development of the final rule, OSHA was not able to identify any employers that performed work covered by Subpart V and did not perform work covered by § 1910.269. However, carrying over assumptions presented in the PRIA, OSHA calculated costs based on an estimate that 5 percent of the affected construction employees performs no work covered by existing § 1910.269, primarily in response to the recommendations of the SBREFA Panel, as discussed in the Initial Regulatory Flexibility Analysis. Therefore, for purposes of estimating the costs of compliance associated with this final rule, OSHA estimates that 5 percent of the affected employees in several construction industries will need to receive the training required by existing § 1910.269 for their employers to achieve full compliance.

Specifically, OSHA estimates that 5 percent of the affected employees in the following industries will require this training: Water, Sewer, and Pipeline Construction; Power and Communication Transmission Line Construction; All Other Heavy Construction; and Electrical Contractors. OSHA also accounted for new hires using an 11- to 16-percent turnover rate, depending on the industry, and accounted for additional costs associated with the transition to the final rule in the first-year by halving the applicable turnover rate for each industry.[545]

One commenter stated:

> While many contractors may be doing work covered by § 1910.269 a good many of them don't think they do or are not aware of it. Many if not all of their employees have never received training required by § 1910.269. We believe that OSHA's estimate of 5% of contractor employees will need this training is way off. [Ex. 0186]

The contractors to which the commenter is referring are already legally obligated to comply with training under § 1910.269. These are costs the employers in question should already be bearing. The costs in this section only capture employers not currently *required* to comply with § 1910.269.

OSHA estimates the costs associated with the additional training necessary to achieve full compliance with the final rule for employees not already trained in accordance with § 1910.269 as involving resources (including labor costs or other expenditures) equivalent to 24.75 hours of employee time plus 3 minutes of clerical time per employee in the affected industries.[546] The Agency also includes a cost for supervisor training not accounted for in the PRIA, with one supervisor trained for every five workers. The Agency updated the assumptions contained in the PRIA to reflect current costs and assumes that these employees will receive their training in a training course at $1,149 per person [28]. OSHA also updated the travel allowance of $90 included in the PRIA to $99 using the Bureau of Economic Analysis' Implicit Price Deflator for Gross Domestic Product [32]. The Agency estimates that the average cost of compliance per affected employee for the required training will range from $2,198 to $2,387 in the affected industries. OSHA estimates current compliance of zero for this part of the analysis [5]. Commenters did not question this assumption.

Thus, the Agency estimates the total one-time cost of compliance for providing additional training for employees not already trained in accordance with § 1910.269 to be $9.2 million. When OSHA annualized this nonrecurring one-time cost at a rate of 7 percent over 10 years, it resulted in estimated total annualized costs of approximately $2.7 million, as shown in Table 34. Table 34 also shows the costs of compliance for each affected industry.

Annual Costs for Additional Training for Employees Not Already Covered by § 1910.269

As noted earlier, OSHA included training costs based on an estimate that 5 percent of the affected construction workforce performs no work covered by § 1910.269. Specifically, OSHA estimates that these training costs would affect 5 percent of the relevant workforce in the following industries: Water, Sewer, and Pipeline Construction; Power and Communication Transmission Line Construction; All Other Heavy Construction; and Electrical Contractors.

OSHA estimated the annual costs associated with this additional training for new affected employees as involving resources (including labor costs or other expenditures) equivalent to 24 hours of supervisor and worker time plus 3 minutes of clerical time per employee. OSHA estimates that the average cost of compliance per affected employee for the required training would range from $2,198 to $741,783 in the affected industries.

The Agency estimated the number of affected employees in each establishment needing training each year by determining the corresponding workforce turnover rate. OSHA estimated the workforce turnover rate associated with the relevant occupational category for each

[545] For a discussion of why the FEA carried over the assumption, presented in the original CONSAD analysis and through the PRIA, of additional one-time training costs related to turnover, see *supra*, footnote 545.

[546] CONSAD estimated the additional training would be equivalent to 24 hours, rather than 24.75 hours, of employee time [5]. OSHA's estimate (which it developed in the PRIA) reflects additional transitional elements associated with these one-time costs.

potentially affected industry. The estimated turnover rates among employees performing electric power generation, transmission, and distribution work ranged from 11 to 16 percent in the affected construction industries [5].

For the establishments and employees affected by the expansion of the scope of this training requirement, OSHA estimated current compliance to be zero [5].

The total estimated annual cost of compliance for providing additional training for employees not already covered by § 1910.269 (and not already provided with such training) was about $0.0 million. Summing the annualized one-time costs and annual costs results in total costs of approximately $0.0 million, as shown in Table 34.

TABLE 34—ANNUALIZED ONE-TIME COSTS AND ANNUAL COSTS FOR ADDITIONAL TRAINING FOR EMPLOYEES NOT ALREADY RECEIVING TRAINING IN ACCORDANCE WITH EXISTING § 1910.269

Industry code	Industry name	Employees affected (%)	Turnover rate (%)	% workers in first-year transition	Average cost per affected employee*	Compliance rate (%)	Annualized one-time compliance costs	Annual costs	Total, annualized and annual costs
NAICS 234910	Water, Sewer, and Pipeline Construction.	5	16	8	$2,314/$26,730	25671	$52,400	$0	$0
NAICS 234920	Power and Communication Transmission Line Construction.	5	16	8	2,314/741,783	772533	1,514,316	0	0
NAICS 234930	Industrial Nonbuilding Structure Construction.	0	NA	NA	NA	0	0	0	0
NAICS 234990	All Other Heavy Construction	5	16	8	2,198/150,006	156411	306,417	0	0
NAICS 235310	Electrical Contractors	5	11	6	2,387/466,573	339587	806,160	0	0
NAICS 235910	Structural Steel Erection Contractors.	0	NA	NA	NA	0	0	0	0
NAICS 235950	Building Equipment and Other Machine Installation Contractors.	0	NA	NA	NA	0	0	0	0
NAICS 235990	All Other Special Trade Contractors.	0	NA	NA	NA	0	0	0	0
NAICS 221110	Electric Power Generation	0	NA	NA	NA	0	0	0	0
NAICS 221120	Electric Power Transmission, Control, and Distribution.	0	NA	NA	NA	0	0	0	0
NAICS 2211	Major Publicly Owned Utilities	0	NA	NA	NA	0	0	0	0
Various	Industrial Power Generators	0	NA	NA	NA	0	0	0	0
SIC 0783	Ornamental Shrub and Tree Services.	0	NA	NA	NA	0	0	0	0
Total						1294201	2,679,293	0	0

*The first value is the one-time cost; the second value is the annual cost.
Notes: (1) Totals may not equal the sum of the components due to rounding.
(2) "NA" = Not Applicable.
(3) For most NAICSs, compliance rates are for small unionized establishments, small nonunionized establishments, large unionized establishments, and large nonunionized establishments, respectively. Major Publicly Owned Utilities (NAICS 2211) and Ornamental Shrub and Tree Services (SIC 0783) only have compliance rates for small and large establishments, and Industrial Power Generators only have a compliance rate for large establishments.
Sources: CONSAD [5], U.S. Census [43, 44, 45, 46].

6. One-Time Costs for Training Qualified Employees in the Use of Fall Protection

The final rule requires qualified employees climbing or changing location on poles, towers, or similar structures to use fall protection equipment unless the employer can demonstrate that climbing or changing location with fall protection is infeasible or creates a greater hazard than climbing or changing location without it. This provision requires the use of new types of fall protection equipment, such as positioning straps with built-in anchorage straps by qualified workers who climb poles to work on electric equipment. Qualified employees will need to receive brief training—OSHA estimates an hour—in the use of the new fall protection equipment. To estimate the ratio of workers who climb or change location on poles, towers, or similar structures to all workers in that industry, OSHA divided the number of line installers and repairers (51,440) in NAICS 221100 (Electric Power Generation, Transmission and Distribution) by the total employment in that NAICS (395,570) [39, 40]. OSHA assumed that the resulting value of 0.13 was similar across all affected NAICSs.[547] In addition to the 13 percent of existing workers affected by this requirement, OSHA accounted for turnover and the first-year transition to the final rule, as previously noted.[548] The compliance rate for this training is necessarily the same as the compliance rate estimated for upgrading fall protection equipment, that is, 50 percent across all affected NAICS. This approach results in estimated total one-time costs of $0.4 million and annualized one-time compliance costs of $0.07 million, as shown in Table 35. Table 35 also shows the costs of compliance for each affected industry.

[547] OSHA's estimates of the one-time costs for training qualified employees in the use of fall protection and the costs for upgrading positioning straps as part of work-positioning equipment are conservative, as OSHA based these estimates on the total number of line installers and repairers, including underground power-line installers and repairers, who generally do not need to climb or change location on poles, towers, or similar structures. Employers will generally neither need to provide and ensure the use of, nor provide training on, the newly required type of work-positioning equipment for this subset of workers.

[548] For a discussion of why the FEA carried over the assumption, presented in the original CONSAD analysis and through the PRIA, of additional one-time training costs related to turnover, see *supra*, footnote 545.

TABLE 35—ANNUALIZED ONE-TIME COSTS FOR TRAINING IN USE OF FALL PROTECTION FOR QUALIFIED EMPLOYEES

Industry code	Industry name	Employees affected (%)	Turnover rate (%)	% workers in first-year transition	Average cost per affected employee	Compliance rate (%)	Annualized one-time compliance costs
NAICS 234910	Water, Sewer, and Pipeline Construction.	0	NA	NA	NA	NA	$0
NAICS 234920	Power and Communication Transmission Line Construction.	13	16	8	$44	50/50/50/50	15,159
NAICS 234930	Industrial Nonbuilding Structure Construction.	0	NA	NA	NA	NA	0
NAICS 234990	All Other Heavy Construction ..	0	NA	NA	NA	NA	0
NAICS 235310	Electrical Contractors	0	NA	NA	NA	NA	0
NAICS 235910	Structural Steel Erection Contractors.	0	NA	NA	NA	NA	0
NAICS 235950	Building Equipment and Other Machine Installation Contractors.	0	NA	NA	NA	NA	0
NAICS 235990	All Other Special Trade Contractors.	0	NA	NA	NA	NA	0
NAICS 221110	Electric Power Generation	13	3	2	52	50/50/50/50	18,235
NAICS 221120	Electric Power Transmission, Control, and Distribution.	13	3	2	52	50/50/50/50	31,159
NAICS 2211	Major Publicly Owned Utilities	13	3	2	52	50/50	4,166
Various	Industrial Power Generators	0	0	0	NA	NA	0
SIC 0783	Ornamental Shrub and Tree Services.	0	NA	NA	NA	NA	0
Total							68,719

Notes: (1) Totals may not equal the sum of the components due to rounding.
(2) "NA" = Not Applicable.
(3) For most NAICSs, compliance rates are for small unionized establishments, small nonunionized establishments, large unionized establishments, and large nonunionized establishments, respectively. Major Publicly Owned Utilities (NAICS 2211) and Ornamental Shrub and Tree Services (SIC 0783) only have compliance rates for small and large establishments, and Industrial Power Generators only have a compliance rate for large establishments.
Sources: BLS [39, 40], CONSAD [5], U.S. Census [43, 44, 45, 46].

7. Costs To Comply With Existing § 1910.269 (Other Than Training) for Employers Not Already Covered by § 1910.269

As described earlier, OSHA believes that construction contractors that perform work involving electric power generation, transmission, or distribution generally comply with the requirements of § 1910.269. Nevertheless, for purposes of estimating the costs of compliance associated with this final rule, OSHA estimated costs associated with complying with existing requirements in § 1910.269 for some construction establishments. Specifically, OSHA estimates that the compliance costs associated with achieving full compliance with the requirements of existing § 1910.269 for the construction industry will be equivalent to that represented by 5 percent of the relevant workforce not being in compliance with the requirements of existing § 1910.269, which OSHA introduced in the general industry standards in 1994. In the PRIA, OSHA identified the affected employees as being in the following industries: Water, Sewer, and Pipeline Construction; Power and Communication Transmission Line Construction; All Other Heavy Construction; and Electrical Contractors. No commenters objected to this approach.

In the analysis of the proposed rule published in 2005, OSHA estimated the resources necessary to achieve compliance with the relevant requirements to average about $64 per employee.[549] This cost is equivalent to that associated with compliance with existing § 1910.269, as supported by the public record developed during promulgation of that standard (59 FR 4320). There were no comments on the PRIA questioning this estimate but OSHA has updated it from $64 in 2005 dollars to $70 in 2009 dollars to account for inflation, using the Bureau of Economic Analysis' Implicit Price Deflator for Gross Domestic Product [32].

Thus, the total estimated annual costs associated with achieving compliance with the nontraining requirements of existing § 1910.269 for the construction industry is $0.2 million, as shown in Table 36. Table 36 also shows the costs of compliance for each affected industry.[550]

[549] OSHA derived this cost, which represents a composite of the various annualized nontraining costs divided by the number of affected employees, from the regulatory impact analysis supporting the 1994 § 1910.269 rulemaking.

[550] This estimated cost increased over that estimated cost in the PRIA because OSHA updated the unit cost and the estimates of power workers in the affected industries (see the approach outlined under the heading "Profile of Affected Industries").

TABLE 36—ANNUAL COSTS TO COMPLY WITH EXISTING § 1910.269 (OTHER THAN TRAINING) FOR EMPLOYEES NOT ALREADY COVERED BY § 1910.269

Industry code	Industry name	Employees affected (%)	Average cost per affected employee	Compliance rates (%)	Annual compliance costs
NAICS 234910	Water, Sewer, and Pipeline Construction	5	$70	0/0/0/0	$4,427
NAICS 234920	Power and Communication Transmission Line Construction	5	70	0/0/0/0	121,855
NAICS 234930	Industrial Nonbuilding Structure Construction	0	NA	NA	NA
NAICS 234990	All Other Heavy Construction	5	70	0/0/0/0	25,941
NAICS 235310	Electrical Contractors	5	70	0/0/0/0	76,067
NAICS 235910	Structural Steel Erection Contractors	0	NA	NA	NA
NAICS 235950	Building Equipment and Other Machine Installation Contractors	0	NA	NA	NA
NAICS 235990	All Other Special Trade Contractors	0	NA	NA	NA
NAICS 221110	Electric Power Generation	0	NA	NA	NA
NAICS 221120	Electric Power Transmission, Control, and Distribution	0	NA	NA	NA
NAICS 2211	Major Publicly Owned Utilities	0	NA	NA	NA
Various	Industrial Power Generators	0	NA	NA	NA
SIC 0783	Ornamental Shrub and Tree Services	0	NA	NA	NA
Total					228,289

Notes: (1) Totals may not equal the sum of the components due to rounding.
(2) "NA" = Not Applicable.
(3) For most NAICSs, compliance rates are for small unionized establishments, small nonunionized establishments, large unionized establishments, and large nonunionized establishments, respectively. Major Publicly Owned Utilities (NAICS 2211) and Ornamental Shrub and Tree Services (SIC 0783) only have compliance rates for small and large establishments, and Industrial Power Generators only have a compliance rate for large establishments.
Sources: CONSAD [5], U.S. Census [43, 44, 45, 46].

8. Annual Costs for Required Communications Between Host Employers and Contract Employers

The final rule requires specific communications between host employers and contract employers. These requirements would apply for each project performed by a contractor.[551] For a complete discussion of the host-contractor provisions of the final rule, see relevant discussion for § 1926.950(c) in Section V, Summary and Explanation of the Final Rule, earlier in this preamble.

Contractors perform an estimated 4,596,731 projects for host employers annually. Contractors in establishments classified in the Power and Communication Transmission Line Construction industry perform about 1,701,656 of those projects, and contractors in establishments classified in the Electrical Contractors industry perform another 1,247,104 of those projects [5, updated by OSHA].[552] OSHA estimates that the requirements for communications between host employers and contract employers will affect 50 percent of projects performed by contractors from small establishments and 100 percent of projects performed by contractors from large establishments. Furthermore, OSHA estimates that between 50 and 90 percent of these projects are already in compliance.[553] This compliance rate results in a total of 932,061 projects that will incur costs under the rule. The final requirements will not affect projects performed by host employers without the use of contract employers, so only projects performed by contract employers result in costs for host employers. To calculate the projects for which hosts will incur costs, OSHA relied on CONSAD's [5] estimate of the percentage of projects performed using contractors, as shown in Table 37.

Some projects will be sufficiently simple, straightforward, and routine as to avoid the need for additional communication beyond what was already occurring between host employers and their contractors before the promulgation of the final rule. The new communication requirements will not affect an estimated 50 percent of the projects performed by establishments with fewer than 20 employees [5]. OSHA determined that these requirements will affect all projects performed by establishments with 20 or more employees [*id.*]

OSHA estimated the costs associated with these provisions as involving resources (including labor costs or other expenditures) equivalent to 10 minutes of supervisory time each for the host employer and the contractor on affected projects involving establishments with fewer than 20 employees and involving resources equivalent to 15 minutes of supervisory time each for the host employer and the contractor on affected projects involving establishments with 20 or more employees [5].[554] OSHA also

[551] Final § 1926.968 defines "contract employer" as "[a]n employer, other than a host employer, that performs work covered by Subpart V of this part under contract." That section also defines "host employer" as "[a]n 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." Thus, under the final rule the contract employer (also called "contractor" in the FEA) is not always under contract to a host employer. However, to simplify the analysis of costs under the final rule, the FEA assumes that every contract employer is working under contract to a host employer. This simplifying assumption should have a negligible effect on costs since contract employers will almost always be working for host employers and, in the remaining cases, the host employer and the contract employer (which is working for a different entity) must still exchange information.

[552] OSHA used CONSAD's approach to estimating the number of projects. That is, the estimated number of projects per year for a given industry is equal to the number of crews (that is, the number of power workers divided by the crew size) multiplied by the number of projects per crew per day (that is, one project), multiplied by the number of workdays per year (250). For most industries, OSHA estimates that a crew consists of three power workers at small establishments and six power workers at large establishments. For Ornamental Shrub and Tree Services (SIC 0783), however, OSHA estimates that a crew consists of two workers at a small establishment and four workers at a large establishment [5].

[553] OSHA notes that there are no costs associated with the provision in the final rule requiring the contract employer and the host employer to coordinate their work rules and procedures so that each employee of the contract employer and the host employer is protected. Because such coordination is essential for the reliable operation of electric power generation, transmission, and distribution systems, OSHA anticipates that host employers and contract employers are virtually in 100-percent compliance already.

[554] OSHA's estimates include the time for gathering, as well as disseminating, the required

estimates that the average cost of compliance for contractors associated with the host-contractor provisions will range from $4.87 to $10.62 per affected project. The corresponding cost of compliance for utilities (host employers) associated with these requirements range from $8.43 to $12.65 per affected project.

OSHA estimates that the communications required by the final rule already occur for most affected projects. Employers involved in an estimated 50 percent of the affected projects performed by smaller establishments are already in compliance with the final requirements, and an estimated 75 to 90 percent of the affected projects performed by larger contractors are also already in compliance. These projects will incur no additional costs to achieve compliance with the final host-contractor provisions. No commenter questioned these estimates of current compliance, originally developed by CONSAD for the PRIA [5].

Thus, OSHA estimates the total annual cost of compliance associated with the final host-contractor provisions to be approximately $17.8 million, as shown in Table 37. This total represents an increase from the PRIA due to a general increase in the number of contractor projects performed annually; furthermore, for reasons discussed in the summary and explanation for final § 1926.950(c), in Section V, Summary and Explanation of the Final Rule, earlier in this preamble, the increase also results from accounting for the percentage of projects affected in the Ornamental Shrub and Tree Services industry. Table 37 also shows the costs of compliance for each affected industry.

EEI questioned OSHA's cost estimate for the host-contractor requirements in the proposed rule (Ex. 0501). EEI's first objection was that "CONSAD gave no attention to the host-contractor provisions when assessing the risk to be addressed by the standard."

OSHA does not find that the extent to which the host-contractor provisions obviate risk has any bearing on the reasonableness of the estimated cost of complying with these provisions.

EEI's second objection was that "the nature of such communications varies widely [depending on] the nature of the particular work being performed, and the relative size of the owners and contractors involved."

As explained previously under the summary and explanation for final § 1926.950(c), in Section V, Summary and Explanation of the Final Rule, earlier in this preamble, OSHA revised the host-contractor provisions to more clearly define the information that hosts and contractors must exchange. With the host-contractor requirements now more clearly defined, OSHA believes that the 10 to 15 minutes of supervisory time used to estimate the costs of these provisions are reasonable. The Agency notes that neither EEI nor any other commenter provided specific information that would enable the Agency to revise its estimate.

TABLE 37—ANNUAL COSTS FOR REQUIRED COMMUNICATIONS BETWEEN HOST EMPLOYERS AND CONTRACTORS

Industry code	Industry name	Contractor projects performed annually*	Projects affected (%) small/large	Compliance rate (%)	Contractor projects affected	Host % of contractor work	Host projects affected	Cost per project (small est.)	Cost per project (large est.)	Annual compliance costs
Contractors										
NAICS 234910	Water, Sewer, and Pipeline Construction.	65,078	50/100	50/50/75/75	16,270	NA	NA	$7.06	$10.59	$150,214
NAICS 234920	Power and Communication Transmission Line Construction.	1,701,656	50/100	65/65/90/90	208,292	NA	NA	7.06	10.59	1,891,463
NAICS 234930	Industrial Nonbuilding Structure Construction.	78,017	50/100	50/50/75/75	19,504	NA	NA	7.05	10.57	204,286
NAICS 234990	All Other Heavy Construction.	410,541	50/100	50/50/75/75	102,635	NA	NA	6.97	10.45	894,356
NAICS 235310	Electrical Contractors	1,247,104	50/100	50/50/75/75	311,776	NA	NA	7.08	10.62	2,702,235
NAICS 235910	Structural Steel Erection Contractors.	21,066	50/100	50/50/75/75	5,267	NA	NA	7.04	10.57	47,763
NAICS 235950	Building Equipment and Other Machine Installation Contractors.	19,739	50/100	50/50/75/75	4,935	NA	NA	7.08	10.62	44,957
NAICS 235990	All Other Special Trade Contractors.	62,701	50/100	50/50/75/75	15,675	NA	NA	6.92	10.39	124,535
SIC 0783	Ornamental Shrub and Tree Services.	990,830	50/100	50/75	247,707	NA	NA	4.87	7.30	1,749,688
Contractor Subtotal.		4,596,731			932,061					7,609,497
Host Employers										
NAICS 221110	Electric Power Generation					23	217,357	8.43	12.65	2,397,541
NAICS 221120	Electric Power Transmission, Control, and Distribution.					62	579,649	8.43	12.65	6,393,786

information. The Agency believes that host employers will most likely gather the required information for each contract as a whole, instead of gathering the information for each project, as this approach to gathering information would be the most cost-effective approach. Thus, the costs of gathering information would be distributed over all projects covered by each contract. Information on the safety aspects of the project should flow from the purely technical aspects of the project, for which consultation should be a logical outcome, thereby resulting in limited and incidental additional burden.

The final rule's time estimates are likely conservative. OSHA retained its estimates from the proposal. However, OSHA also revised the host-contractor requirements in the final rule in response to numerous comments, including comments from the Small Business Administration's Office of Advocacy (Ex. 0207). The revisions should lower compliance burdens and reduce costs for host employers and contract employers.

TABLE 37—ANNUAL COSTS FOR REQUIRED COMMUNICATIONS BETWEEN HOST EMPLOYERS AND CONTRACTORS—Continued

Industry code	Industry name	Contractor projects performed annually*	Projects affected (%) small/large	Compliance rate (%)	Contractor projects affected	Host % of contractor work	Host projects affected	Cost per project (small est.)	Cost per project (large est.)	Annual compliance costs
NAICS 2211	Major Publicly Owned Utilities.					6	51,823	8.43	12.65	571,626
Various	Industrial Power Generators					9	83,233	NA	12.65	648,391
Various Host Employer Subtotal.							932,061			10,011,344
Total							932,061			17,820,841

*The table excludes projects performed directly by host employer utilities as they do not involve communications between host employers and contractors. The costs to utilities consist of costs to communicate with contractors on the projects contractors perform for utilities.

Notes: (1) Totals may not equal the sum of the components due to rounding.

(2) "NA" = Not Applicable.

(3) For most NAICSs, compliance rates are for small unionized establishments, small nonunionized establishments, large unionized establishments, and large nonunionized establishments, respectively. Major Publicly Owned Utilities (NAICS 2211) and Ornamental Shrub and Tree Services (SIC 0783) only have compliance rates for small and large establishments, and Industrial Power Generators only have a compliance rate for large establishments.

Sources: CONSAD [5], U.S. Census [43, 44, 45, 46].

9. Annual Costs Associated With Expanded Requirements for Job Briefings

The final rule expands existing requirements for employers to conduct job briefings before employees begin work on affected projects. Specifically, the final rule requires affected employers to provide the employee in charge of the job with all available information that relates to the determination of existing characteristics and conditions that the crew must complete.

OSHA estimates that employers perform 9,953,249 projects in the construction, utility, power generation, and line-clearance tree-trimming industries annually [5, updated by OSHA]. Of these employers, the industries with the highest annual compliance costs, the Power and Communication Transmission Line Construction industry and the Electrical Contractors industry, perform an estimated 1,701,656 projects and 1,247,104 projects, respectively (*id.*). While the final rule potentially affects 100 percent of all 9,953,249 projects, between 85 and 98 percent of the projects are already in compliance [5].

Employers can achieve compliance with the final rule through the following small addition to routine communications that already take place regularly between employers and employees involved in the affected projects. Specifically, OSHA estimates the costs of compliance associated with the final job-briefing requirement to involve resources (including labor costs or other expenditures) equivalent to 5 minutes of supervisory time and 5 minutes of employee time for each employee on each affected project [5].[555]

Thus, OSHA estimates that the average cost of compliance associated with the final requirements for job briefings will be $8.48 to $21.21 per affected project performed by utilities, other power generators, and construction contractors. The estimated average cost of compliance for projects performed by establishments in the Ornamental Shrub and Tree Services industry is about $4.20 to $7.75 per project.

For the PRIA, based on research by CONSAD, OSHA estimated that employers already provide the required information to the employee in charge for most affected projects. Commenters on the proposal did not question these assumptions. OSHA estimates that employers (other than utilities and other power generators) involved in an estimated 85 percent of the affected projects performed by establishments with fewer than 20 employees are already in compliance with the final requirements, while employers (other than utilities and other power generators) involved in an estimated 95 percent of the affected projects performed by establishments with 20 or more employees also are already in compliance with the final requirements [5]. Among utilities and other power generators, an estimated 95 percent to 98 percent of the potentially affected projects involve employers already fully in compliance with the final provisions [*id.*]. For projects already in compliance, employers will incur no additional costs to achieve compliance with the final rule [*id.*].

The total estimated annual cost of compliance associated with the final requirement to provide information to the employee in charge is, thus, approximately $6.7 million, as shown in Table 38. Table 38 also shows the costs of compliance for each affected industry.

[555] Consistent with the assumption on the number of total employees per project, the costs also reflect one supervisor per project, plus two regular employees per project at small establishments, and five regular employees at large establishments, except in Ornamental Shrub and Tree Services (SIC 0783), where it is one regular employee at small establishments and three at large establishments. OSHA's cost estimate is probably overly conservative. OSHA believes that it should not, on average, take any additional time (over the time already required to conduct a job briefing under existing § 1910.269) for the employee in charge to brief the rest of the employees about the information the employer must supply the employee in charge pursuant to the final rule. In fact, in some cases, the final rule could reduce the time needed to conduct a job briefing. For example, if the employer tells the employee in charge that a utility pole on the job is cracked and that the pole's ability to support additional weight is suspect, the employee in charge would no longer need to go over the pole inspection in as much detail, although the employee in charge would have to discuss pole-bracing procedures, during the job briefing. If the employer had not reported this information, the employee in charge would cover the pole inspection, but not bracing procedures, during the job briefing. However, after the employees discovered the crack, the employee in charge would need to hold a second job briefing (and expend additional time) to go over the bracing procedures.

TABLE 38—ANNUAL COSTS ASSOCIATED WITH JOB BRIEFINGS

Industry code	Industry name	Projects performed annually	Projects affected (%) small/large	Cost per project (small est.)	Cost per project (large est.)	Compliance rate (%)	Annual compliance costs
NAICS 234910	Water, Sewer, and Pipeline Construction.	65,078	100/100	$9.29	$17.92	85/85/95/95	$70,743
NAICS 234920	Power and Communication Transmission Line Construction.	1,701,656	100/100	9.29	17.92	85/85/95/95	1,777,657
NAICS 234930	Industrial Nonbuilding Structure Construction.	78,017	100/100	9.28	17.92	85/85/95/95	70,999
NAICS 234990	All Other Heavy Construction	410,541	100/100	8.48	15.98	85/85/95/95	424,921
NAICS 235310	Electrical Contractors	1,247,104	100/100	9.79	19.16	85/85/95/95	1,545,162
NAICS 235910	Structural Steel Erection Contractors.	21,066	100/100	9.77	19.14	85/85/95/95	24,717
NAICS 235950	Building Equipment and Other Machine Installation Contractors.	19,739	100/100	9.79	19.16	85/85/95/95	23,197
NAICS 235990	All Other Special Trade Contractors.	62,701	100/100	8.58	16.26	85/85/95/95	71,957
NAICS 221110	Electric Power Generation	1,582,025	100/100	11.01	21.21	95/95/98/98	675,284
NAICS 221120	Electric Power Transmission, Control, and Distribution.	2,689,805	100/100	11.01	21.21	95/95/98/98	1,144,815
NAICS 2211	Major Publicly Owned Utilities	360,869	100/100	11.01	21.21	95/98	153,887
Various	Industrial Power Generators	723,820	100/100	21.21	21.21	98	306,992
SIC 0783	Ornamental Shrub and Tree Services.	990,830	100/100	4.20	7.75	85/95	407,227
Total		9,953,249					6,697,557

Notes: (1) Totals may not equal the sum of the components due to rounding.
(2) For most NAICSs, compliance rates are for small unionized establishments, small nonunionized establishments, large unionized establishments, and large nonunionized establishments, respectively. Major Publicly Owned Utilities (NAICS 2211) and Ornamental Shrub and Tree Services (SIC 0783) only have compliance rates for small and large establishments, and Industrial Power Generators only have a compliance rate for large establishments.
Sources: CONSAD [5], U.S. Census [43, 44, 45, 46].

10. Costs Associated With Arc-Hazard Assessment

Paragraph (g)(1) of final § 1926.960 requires the employer to assess employee workplace exposures to hazards from flames or from electric arcs. Paragraph (g)(2) of final § 1926.960 requires the employer to make a reasonable estimate, for each exposed employee, of the incident heat energy associated with hazards from electric arcs. The FEA estimates the cost for both provisions simultaneously in this section because, as part of the effort to calculate incident energy, the employer necessarily must assess the hazards to employees. The FEA also uses the term "arc-hazard assessment" to refer to both requirements.

For the proposed rule, the PRIA used an approach based on the CONSAD report [5], calculating annual costs on a per-project and per-employee basis. Some commenters questioned this approach, which projected a cost of $2 per project. (See, for example, Exs. 0208, 0505.) OSHA modified the PRIA methodology for arc-hazard assessment and instead is calculating primarily one-time costs on a per-firm basis. OSHA modified the methodology because it is not necessary to recalculate the costs for each project; the Agency believes that, except with respect to power generation installations as discussed later, a system-wide calculation is a more logical outcome of the rule.[556]

OSHA also is not accounting for costs to contractors in the final rule (a second modification from the PRIA). The Agency believes that, as utilities will need to perform the calculations on their own systems either in-house or using engineering consultants, utilities will provide information on potential heat energy to contractors, even though the final rule does not explicitly require utilities to do so. Otherwise, host employers would incur costs associated with those estimates twice, once when the host employer generates the estimate and a second time when the contractor passes the costs of generating the estimate back to the host employer.

As in the PRIA, OSHA estimates that 75 percent of small utilities and 85 percent of large utilities already performed the necessary calculations and will not incur costs under the rule. For the remaining utilities, which will have to estimate the available heat energy that would result from electric arcs, the approach will likely vary depending on the size of the utility. OSHA believes that small utilities would likely hire a consultant to perform the calculations for them, while large utilities would likely use commercially available software and perform the calculations in-house.

OSHA estimates that the 25 percent of small utilities that do not already perform the calculations will hire a consultant to provide estimates of incident-heat-energy exposures. OSHA estimates that it will take a consultant 28 hours to perform the calculations at a rate of $250 per hour, for an average cost of $7000 per affected utility and a total of approximately $1.2 million for all affected small utilities.[557] When OSHA annualized this cost at 7 percent over 10 years, it results in annualized costs for affected small utilities of approximately $0.03 million.

Large utilities are more likely than small utilities to face situations not

[556] Since employers do not need to perform extensive recalculations of their systems annually, as assumed in the PRIA, the estimated annualized cost of this provision is substantially less than the estimated cost in the PRIA.

[557] While small utilities have the option of using the tables OSHA provides, this FEA conservatively assumed they will use the more expensive option of hiring consultants.

covered by the tables in Appendix E. These utilities can perform the calculations using several different methods. The proposed rule allowed employers to use Allen Privette's Heat Flux Calculator, a free software program widely available on the Internet, to perform the calculations. After considering comments from rulemaking participants, OSHA determined that the Heat Flux Calculator is not a reasonable method for estimating incident energy regardless of exposure or voltage. (See the discussion of final § 1926.960(g)(2) in Section V, Summary and Explanation of the Final Rule, earlier in this preamble.) Many utilities already use a more reliable means of calculating incident heat energy, but some utilities will have to buy software to estimate incident heat energy. OSHA estimates that 15 percent of large utilities will need to purchase software, at a cost of approximately $2,500 per firm [7].

For the large utilities buying software, an engineer will have to input parameters into the software to determine the incident-heat energy that would result from electric arcs. These parameters include fault current, the expected length of the electric arc, the distance from the arc to the employee, and the clearing time for the fault. OSHA estimates that performing this task for all affected large-utility employees will require 500 engineering hours per affected firm, at the estimated hourly rate for an engineer of $47.17. This determination results in engineering costs of $25,970 per affected firm, and total engineering costs for all affected firms of $6.5 million. Consistent with the ratio of engineering time to clerical time used in the PRIA, these same firms will also incur clerical costs, equivalent to 25 hours of clerical time at a wage of $28.75 per hour, or $719 per utility. This determination results in total clerical costs for all affected firms of approximately $0.2 million. Summing software, engineering labor, and clerical labor costs for all affected large firms results in total costs of $6.7 million and annualized costs of $2.1 million.

TVA estimated that costs should be about $300 per employee (Ex. 0213). The PRIA estimated 2 hours of engineering time per employee and $2 per project.[558]

[558] OSHA believes that (with the exception of power generation facilities, as discussed later) it likely overestimated the cost of performing the calculations, particularly with respect to distribution installations. This belief is based in part on expert opinion provided to ERG, which suggested that the calculations would require substantially fewer hours than indicated by TVA [8].

The Agency concluded that, because electric utilities will likely perform calculations on a per-circuit, rather than per-project or per-employee, basis and because the number of circuits operated by a utility is generally proportional to the size of that utility, the costs should be based on the number of hours the utility will take to perform the calculations as determined by the size of the utility. Consequently, the per-employee basis used by TVA and the per-employee and per-project basis used by the PRIA are generally unsuitable for estimating costs related to calculating incident energy.

However, TVA's description of the methodology it used in calculating incident energy suggests that TVA included costs associated with lowering incident energy at a nuclear power generation plant. As explained in the summary and explanation for final § 1926.960(g)(5), in Section V, Summary and Explanation of the Final Rule, earlier in this preamble, OSHA believes that any such measures requiring substantial expenditures are likely to be necessary only for electric power generation installations. To account for the costs of adopting incident-energy-control measures for electric power generation installations, OSHA included costs for reducing incident-energy exposures that, when combined with OSHA's estimated costs for calculating incident energy, correspond to TVA's estimate of $300 per employee for firms in industries with generation installations.

Thus, OSHA included costs in this FEA to account for additional engineering controls that employers with power generation installations might need to implement to reduce the incident energy of particular circuits to no more than 100 cal/cm^2 (the maximum level for which protective clothing and equipment are generally available). Such engineering controls might include installing current-limiting devices, resetting circuit breaker trip devices, and using remote control operating and test equipment.

To estimate the cost of these potential engineering controls, OSHA relied on the TVA estimate that the arc-hazard assessment will cost about $300 per employee. For each relevant industry affected by the need to implement these potential controls (the utilities in the Electric Power Generation industry (NAICS 221100), all Industrial Power Generators (Various NAICS), and Major Publicly-Owned Utilities (NAICS 2211) judged to operate power generation installations), TVA's total estimated costs for the arc-hazard assessment were higher than the costs estimated by OSHA for this assessment. OSHA attributed the difference in cost between the two estimates to the additional engineering controls that OSHA identified for the final rule. TVA stated in its comments to the proposed rule that TVA based its estimates "on all circuits" (including, presumably, circuits that require a reduction in incident energy using engineering controls) and that its estimates did not include the cost of purchasing arc-flash protective equipment (Ex. 0213).

To account for the additional engineering control costs, OSHA increased the cost of the arc-hazard assessments (which include the cost for engineering controls) for utilities having power generation installations above what OSHA already estimated for the assessment so that the total averaged $300 per power worker employee, consistent with TVA's cost estimate. (For example, for a given industry, if the cost of the arc-hazard assessment, without the engineering controls adjustment, amounted to $150 per employee, OSHA increased the cost by $150 per employee to account for the adjustment.) OSHA also assumed that existing compliance rates associated with these engineering controls are identical to the compliance rates estimated for the unadjusted arc-hazard assessment (that is, the compliance rate estimated for the arc-hazard assessment without the addition of engineering controls).

To calculate the percentage of firms in the Major Publicly-Owned Utilities industry that operate generating plants (and thus power generation installations), OSHA first cross-referenced OSHA's estimate of 277 firms that are in the Major Publicly-Owned Utilities industry against the 2008 EIA Form 860 database, which provides a nationwide census of generating plants by owner [49]. This comparison showed that 106 of the firms that are in the Major Publicly-Owned Utilities industry and that are under the scope of the final rule own generating plants. OSHA then assumed that the distribution by size of this subset would mirror that of the entire Major Publicly-Owned Utilities population, resulting in an estimated 13 small firms and 93 large firms that are Major Publicly-Owned Utilities with generating facilities.

As indicated in Table 39, the Agency estimates that the annualized one-time cost for these engineering controls is approximately $26,737 for small firms and $2,123,110 for large firms, for a total of $2,149,847 for all affected firms.

Summing software costs, engineering labor, clerical labor, consulting, and incident-energy reduction costs for both

small and large firms results in total estimated costs for all affected firms of $10.6 million. When this one-time cost is annualized at a 7-percent interest rate over 10 years, the resulting annualized costs are approximately $1.5 million as shown in Table 39. Table 39 also shows the costs of compliance for each affected industry.

TVA asserted that the costs associated with arc-hazard assessments recur annually (Ex. 0213). TVA indicated that performing such a calculation, while time consuming initially, is not nearly as time consuming when performed on an ongoing basis. TVA suggested the ongoing cost would be only 3 percent of the initial cost (*id.*).

As explained later, the Agency took a more conservative approach by assuming annual ongoing costs of 10 percent of the initial cost. This approach includes an annual assessment to examine any changes in conditions and the costs of a potential recalculation of the system. (See Table 40.)

One commenter suggested that liability costs would rise due to consultants underestimating incident heat energy (Ex. 0178).

OSHA believes that this comment is speculative and without merit. Moreover, as a practical matter, the typical consultant would likely carry personal liability insurance and, therefore, factors this cost into his or her consulting fees (which the Agency is assuming will be $250 an hour, on average). Also, the commenter did not establish why these determinations present a new source of liability, as firms (whether consultants or utilities) that perform such calculations now are liable for any flawed estimates given to others.

Another commenter suggested that electrical contractors may find it especially demanding to comply with the arc-hazard assessment provision because of the difficulties involved in training a highly mobile workforce to understand a constantly changing variety of electrical systems and because of the difficulties resulting from contractors' working for a variety of utilities (Ex. 0501).

OSHA believes that the commenter's concerns are groundless. First, as stated earlier, the Agency accounted for any costs related to training and included in its calculations the costs specific to each affected industry. Second, as also stated earlier, the Agency expects that host employers will pass information related to potential heat-energy hazards to the contractors during the exchange of information between host employers and contract employers, as doing so is in their economic self-interest. As such, varying work situations and a mobile workforce should not pose major issues for contractors.[559]

TABLE 39—ANNUALIZED ONE-TIME COSTS ASSOCIATED WITH ARC-HAZARD ASSESSMENT

Industry code	Industry name	Compliance rate (%)	Firms using consultant (% of small)	Consulting hours per firm	Total consulting costs	Incident-energy reduction costs	Total annualized costs—small firms
			Small Firms				
NAICS 234910	Water, Sewer, and Pipeline Construction.	NA	NA	NA	NA	NA	NA
NAICS 234920	Power and Communication Transmission Line Construction.	NA	NA	NA	NA	NA	NA
NAICS 234930	Industrial Nonbuilding Structure Construction.	NA	NA	NA	NA	NA	NA
NAICS 234990	All Other Heavy Construction	NA	NA	NA	NA	NA	NA
NAICS 235310	Electrical Contractors	NA	NA	NA	NA	NA	NA
NAICS 235910	Structural Steel Erection Contractors.	NA	NA	NA	NA	NA	NA
NAICS 235950	Building Equipment and Other Machine Installation Contractors.	NA	NA	NA	NA	NA	NA
NAICS 235990	All Other Special Trade Contractors.	NA	NA	NA	NA	NA	NA
NAICS 221110	Electric Power Generation	75	25	28	$553,000	$25,461	$82,360
NAICS 221120	Electric Power Transmission, Control, and Distribution.	75	25	28	563,500	NA	80,230
NAICS 2211	Major Publicly Owned Utilities	75	25	28	57,750	1,276	8,404
Various	Industrial Power Generators	NA	NA	NA	NA	NA	0
SIC 0783	Ornamental Shrub and Tree Services.	NA	NA	NA	NA	NA	NA
Total					1,174,250	26,737	170,994

[559] The commenter also stated that electrical contractors would incur a special burden in conjunction with the final rule's arc-flash protective equipment requirements. As discussed later, the Agency is costing eight pairs of flame-resistant clothing, which should be sufficient to cover the different situations contractors might face.

TABLE 39—ANNUALIZED ONE-TIME COSTS ASSOCIATED WITH ARC-HAZARD ASSESSMENT
[Continued]

Industry code	Industry name	Compliance rate (%)	Firms purchasing software (% of large)	Software cost per firm	Total software cost	Firms with engineering hours (% of large)	Engineering hours per firm	Total engineering costs	Clerical hours per firm	Total clerical costs	Incident-energy reduction costs	Total annualized costs—large firms
Large Firms												
NAICS 234910 ...	Water, Sewer, and Pipeline Construction ..	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NAICS 234920 ...	Power and Communication Transmission Line Construction.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NAICS 234930 ...	Industrial Nonbuilding Structure Construction.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NAICS 234990 ...	All Other Heavy Construction	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NAICS 235310 ...	Electrical Contractors	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NAICS 235910 ...	Structural Steel Erection Contractors	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NAICS 235950 ...	Building Equipment and Other Machine Installation Contractors.	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NAICS 235990 ...	All Other Special Trade Contractors	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
NAICS 221110 ...	Electric Power Generation	85	15	$2,500	$116,250	15	500	$1,207,532	25	$33,424	$1,388,374	$390,909
NAICS 221120 ...	Electric Power Transmission, Control, and Distribution.	85	15	2,500	341,250	15	500	3,544,692	25	98,115	NA	567,240
NAICS 2211	Major Publicly Owned Utilities	85	15	2,500	91,500	15	500	950,445	25	26,308	82,382	163,825
Various	Industrial Power Generators	85	15	2,500	73,875	15	500	767,367	25	21,240	652,353	215,679
SIC 0783	Ornamental Shrub and Tree Services	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Total	.....	.....	.....	.....	622,875	.....	.....	6,470,036	.....	179,088	2,123,110	1,337,652

TABLE 39—ANNUALIZED ONE-TIME COSTS ASSOCIATED WITH ARC-HAZARD ASSESSMENT
[Continued]

Industry code	Industry name	Total annualized costs—all firms
	All Firms	
NAICS 234910	Water, Sewer, and Pipeline Construction	NA
NAICS 234920	Power and Communication Transmission Line Construction	NA
NAICS 234930	Industrial Nonbuilding Structure Construction	NA
NAICS 234990	All Other Heavy Construction	NA
NAICS 235310	Electrical Contractors	NA
NAICS 235910	Structural Steel Erection Contractors	NA
NAICS 235950	Building Equipment and Other Machine Installation Contractors	NA
NAICS 235990	All Other Special Trade Contractors	NA
NAICS 221110	Electric Power Generation	473,269
NAICS 221120	Electric Power Transmission, Control, and Distribution	647,470
NAICS 2211	Major Publicly Owned Utilities	172,228
Various	Industrial Power Generators	215,679
SIC 0783	Ornamental Shrub and Tree Services	NA
Total		1,508,646

Notes: (1) Totals may not equal the sum of the components due to rounding.
(2) "NA" = Not Applicable.
(3) All Industrial Power Generators are large establishments.
Sources: ERG estimates, Cress [7], U.S. Census [43, 44, 45, 46].

OSHA also accounted for the periodic costs associated with updating arc-hazard assessments, as necessary. As explained in discussion of final § 1926.960(g)(2) in Section V, Summary and Explanation of the Final Rule, earlier in this preamble, while commenters' concerns that employers would need to constantly update their incident-energy estimates are baseless, periodic updates may be necessary under certain limited circumstances. As mentioned earlier, OSHA estimates that this periodic labor cost is equal to 10 percent of the total one-time consulting, engineering, and clerical costs indicated in Table 39. When OSHA annualized the present value of this recurring labor cost[560] at 7 percent over 10 years, total annualized costs for all affected industries are $0.7 million. When OSHA included these periodic costs with the one-time arc-hazard assessment costs calculated earlier, total annualized arc-hazard assessment costs are approximately $2.2 million, as shown in Table 40.

TABLE 40—TOTAL ANNUALIZED COSTS ASSOCIATED WITH ARC-HAZARD ASSESSMENT

Industry code	Industry name	Annual labor costs (years 2–10)	Present value of labor costs (years 2–10)	Total annualized updating cost	Total annualized arc-hazard assessment costs
NAICS 234910	Water, Sewer, and Pipeline Construction	NA	NA	NA	NA
NAICS 234920	Power and Communication Transmission Line Construction.	NA	NA	NA	NA
NAICS 234930	Industrial Nonbuilding Structure Construction	NA	NA	NA	NA
NAICS 234990	All Other Heavy Construction	NA	NA	NA	NA
NAICS 235310	Electrical Contractors	NA	NA	NA	NA
NAICS 235910	Structural Steel Erection Contractors	NA	NA	NA	NA
NAICS 235950	Building Equipment and Other Machine Installation Contractors.	NA	NA	NA	NA
NAICS 235990	All Other Special Trade Contractors	NA	NA	NA	NA
NAICS 221110	Electric Power Generation	$179,396	$1,092,340	$155,525	$628,793
NAICS 221120	Electric Power Transmission, Control, and Distribution	420,631	2,561,221	364,660	1,012,130
NAICS 2211	Major Publicly Owned Utilities	103,450	629,909	89,685	261,913
Various	Industrial Power Generators	78,861	480,183	68,367	284,046
SIC 0783	Ornamental Shrub and Tree Services	NA	NA	NA	NA
Total		782,337	4,763,654	678,237	2,186,883

Notes: (1) Totals may not equal the sum of the components due to rounding.
(2) "NA" = Not Applicable.
Source: ERG estimate.

[560] OSHA computed the present value for 9 years of costs, beginning with the year after the arc-hazard assessment provision goes into effect and lasting through year 10.

Costs for Providing Arc-Flash Protective Equipment

The final rule requires affected employers to ensure that employees exposed to certain hazards wear flame-resistant clothing. The final rule also requires employers to ensure that each employee exposed to electric-arc hazards wears clothing with an arc rating greater than or equal to the applicable estimate of incident heat energy. Generally, the arc-rated clothing must cover the employee's entire body, although there are limited situations in which the final rule does not require arc-rated protection for the employee's hands, feet, or head. As previously mentioned in this analysis, OSHA uses the term "flame-resistant clothing" to refer generally to the flame-resistant and arc-rated clothing, and the term "arc-flash protective equipment" to refer to the flame-resistant and arc-rated clothing and equipment, required by § 1926.960(g).

OSHA estimated the average costs associated with providing the clothing that will be necessary to achieve full compliance with the final rule to involve resources equivalent to those associated with the following case example. An employer could generally achieve compliance with the final rule's clothing provisions by purchasing eight sets of flame-resistant clothing per employee and one switching coat or flash suit for every three employees.

OSHA estimated a single set of flame-resistant clothing to cost $191.75 [13]; and, with eight sets provided for each employee (at a total cost of $1,534.00 per employee), the Agency assumed that the useful life of this apparel was 4 years [5]. OSHA estimated a switching coat or flash suit to cost about $226.00 [19] and to have an expected life of 10 years [5]. Because use of the switching coat or flash suit will be intermittent, OSHA estimated that employers will need to provide only one switching coat or flash suit for every three affected employees [5].

Frank Brockman of the Farmers Rural Electric Cooperative Corporation commented on the costs of flame-resistant apparel (Ex. 0173). Mr. Brockman estimated that the cost of flame-resistant clothing would be in excess of $1,000 per employee.

OSHA notes that the cost estimate used in this FEA ($1,534.00 per employee for flame-resistant clothing exclusive of switching coats) is consistent with Mr. Brockman's estimate.

Employers generally will substitute flame-resistant clothing for clothing that the employee or the employer would already be providing. OSHA did not include in this analysis the savings associated with employees' no longer needing to purchase and launder the clothing that employees would otherwise wear.

The final rule does not require employers to launder protective clothing for employees. To the extent that employers choose to begin laundering clothing or provide laundering services for employees in conjunction with providing flame-resistant clothing, the cost is not attributable to this final rule; and OSHA regards any such costs as transfers from employers to employees rather than additional costs to society.

Based on research conducted by CONSAD, OSHA estimates that most establishments in all affected industries already provide employees with flame-resistant clothing that fully complies with the requirements of the final rule [5]. These establishments, therefore, will incur no additional costs to achieve compliance with the final rule's requirements for flame-resistant clothing.

For each affected industry, OSHA estimated rates of current compliance with the final requirements to provide arc-rated clothing. Within each industry, the Agency estimated rates of current compliance separately for establishments based on their size. Among construction contractors, the estimated average rate of current compliance for establishments with fewer than 20 employees is 50 percent. The average rate of current compliance among construction-contractor establishments with 20 or more employees is an estimated 75 percent. Among electric utilities and other electric power generators, current compliance is an estimated 80 percent for establishments with fewer than 20 employees and 90 percent for establishments with 20 or more employees [5].

In his comments, Frank Brockman of the Farmers Rural Electric Cooperatives Corporation estimated that the flame-resistant clothing provision of the rule would affect 25 percent of the relevant workforce, for an implied compliance rate of 75 percent (Ex. 0173). This estimate is similar to the compliance estimates developed by CONSAD [5], which range from 50 percent to 90 percent depending on the industry and establishment size, for an industry-wide average of 78-percent compliance.

The total estimated annualized cost of compliance for providing flame-resistant clothing is approximately $15.6 million, as shown in Table 41. The total estimated annualized cost of compliance for providing switching coats or flash suits is approximately $0.4 million as shown in Table 42. Table 41 and Table 42 also show the costs of compliance for each affected industry. Together, the total estimated annualized cost of providing flame-resistant apparel and switching coats is approximately $16.0 million.

In addition to clothing and switching coats or flash suits, the final rule requires the provision of face and head protection for workers in certain circumstances, typically when the workers perform energized work on equipment in enclosures and when work involves exposures to three-phase arcs. OSHA did not estimate costs in connection with face and head protection for the PRIA. To estimate the number of affected Electrical Power-Line Installers and Repairers (SOC 49–9051) for the final rule, OSHA calculated the number of line installers and repairers (that is, 51,440) as a percentage of total employment in NAICS 221100—Electric Power Generation, Transmission and Distribution (that is, 395,570) [39, 40], and assumed that this percentage (that is, 13 percent) was similar across all affected NAICS. OSHA believes that none of these workers currently use arc-rated face and head protection. To estimate the number of affected Electrical and Electronics Repairers working in generating stations, substations, and in-service relays (SOC 49–2095), OSHA calculated the number of Electrical and Electronics Repairers (that is, 17,240) as a percentage of total employment in NAICS 221100—Electric Power Generation, Transmission and Distribution (that is, 395,570) [40, 41] and assumed that this percentage (that is, 4 percent) was similar across all affected NAICSs. OSHA believes that the use of arc-rated face and head protection is fairly common by these workers and estimates current compliance among the affected industry groups to range from 50 to 90 percent (equivalent to the compliance rates for flame-resistant clothing (Table 41) and switching coats or flash suits (Table 42).

Based on publicly available information from vendors of electrical protective equipment, OSHA estimates that a faceshield costs $86.50 (with a useful life of 2 years), and that head protection such as a balaclava costs $29.75 (with a useful life of 2 years) [11, 12]. Testimony suggesting that faceshields might run $60 and that balaclava might run $30 corroborates these cost estimates (Tr. 479).

When OSHA annualized the costs of arc-rated face and head protection at a 7-percent interest rate over the useful

life of the equipment, the resulting total estimated costs are approximately $0.9 million for faceshields and $0.3 million for head protection, as shown in Table 43 and Table 44, and Table 45 and Table 46, respectively. These tables also show the costs of compliance for each affected industry.

Summing the costs for flame-resistant clothing, switching coats or flash suits, faceshields, and head protection results in total estimated annualized costs of approximately $17.2 million.[561]

Using Mr. Brockman's (Ex. 0173) approach to calculating costs for flame-resistant clothing, along with OSHA's estimate of the number of affected workers, results in a "Brockman" estimate of $48.9 million.[562] However, Mr. Brockman did not annualize his estimated costs. Doing so using an interest rate of 7 percent over the 4-year expected life of flame-resistant clothing[563] results in an annualized cost estimate of $14.4 million. OSHA notes that this estimate is less than both OSHA's estimate of annualized costs for flame-resistant clothing alone $15.6 million) and OSHA's estimate of annualized costs for all arc-flash protective equipment ($17.3 million). As such, OSHA's estimate is entirely reasonable.

One commenter emphasized that workers typically wear multiple layers of clothing and complained that the proposal would require additional costs for the various layers of clothing (Ex. 0186).

The final rule clarifies that only the outer layer of clothing must be flame-resistant.

Another commenter suggested the cost analysis should account for "selecting and fitting" of apparel (Ex. 0240).

The commenter's use of the terms "selecting and fitting" here is somewhat ambiguous; in any event, the Agency already accounted for the key informational element in selecting and fitting apparel—the arc-hazard assessment. OSHA believes that once employers perform this assessment, any other elements of selecting and fitting clothing (such as selecting brand or vendor or size) is a negligible part of the overall cost.

Some commenters argued that flame-resistant clothing required special laundering and that this would be an additional cost. (See, for example, Ex. 0186.)

OSHA concludes that there is no additional cost associated with laundering the flame-resistant clothing required by the final rule. First, as stated, the final rule does not require employers to launder protective clothing for employees; and, therefore, while employers may choose to launder protective clothing for their employees, the rule does not impose the cost of laundering on employers. Second, according to the record, employers or their employees can generally follow the manufacturers' care instructions that come with the clothing (Tr. 305—306, 1373—1374), and there is generally no additional cost to employees over that of laundering normal (that is, non-flame-resistant) clothing. Even if employees needed some training on how to care for flame-resistant clothing to ensure that the clothing does not lose its flame-resistant properties (as some commenters argued (Ex. 0186)), the training provisions of the final rule (costed previously in this analysis) would cover this cost (that is, the Agency assumes all employers will give their employees the requisite training to come into compliance with the standard).

One commenter argued that the life of flame-resistant clothing was less than the 4-year period used by OSHA in its calculations (Ex. 0173). A witness at the 2006 public hearing testified that the life of flame-resistant clothing varied considerably and might well last more than 4 years; this witness spoke of the enhanced durability of newer flame-resistant materials that were emerging at the time of the hearing (Tr. 1374). (See, also, Tr. 1192.) One commenter believed that OSHA should assume that employees require a slightly larger number of sets of clothing (Ex. 0186). Other commenters stated that less clothing would be adequate (Ex. 0099; Tr. 387, 828, 1374). Another commenter mentioned a possible range of 5 to 14 sets (Tr. 309).[564] Other commenters stated that the estimate does not take into account all types of clothing required, such as winter wear (see, for example, Ex. 0173).

OSHA notes that its estimate of eight sets is in the middle of the number of sets recommended by the commenters. Moreover, as indicated in the PRIA, OSHA significantly increased its initial estimate of clothing costs in response to comments from SERs during the SBREFA Panel process. For the FEA, the Agency is basing its estimates on a cost of $1,534.00 per employee for eight sets of flame-resistant clothing (using the estimated cost of $191.75 per set), or on an annualized cost of approximately $452.88 per employee. The Agency believes this final estimate is reasonable and captures the *average cost* of all flame-resistant clothing required by the new provisions of the final standard. In this regard, the record indicates that annual employee stipends to cover all flame-resistant clothing typically run $125—250 (Tr. 828). This evidence supports the conclusion that OSHA's estimate is reasonable, if not conservative.

[561] While the final rule added some minor cost elements to the costs estimated in the proposal, the higher estimated cost of protective clothing in the FEA, relative to the PRIA, is due primarily to the higher estimated unit cost for the eight pairs of flame-resistant clothing.

[562] In his comments, Mr. Brockman calculated costs for workers in all affected establishments. This approach was erroneous, however, because the protective-clothing provisions of the final rule do not cover employees in the Ornamental Shrub and Tree Services industry. OSHA excluded the tree-care employees from Mr. Brockman's calculation to arrive at a corrected estimate, using Mr. Brockman's analysis, of $48.9 million.

[563] Mr. Brockman apparently estimated a cost for flame-resistant clothing only, but not other equipment such as switching coats or flash suits, as Mr. Brockman's estimate referred only to OSHA's proposed 4-year useful-life estimate for flame-resistant clothing, not OSHA's proposed 10-year useful-life estimate for switching coats or flash suits (Ex. 0173; 70 FR 34915–34916).

[564] OSHA examined the effect of changing the costs for flame-resistant clothing using either end of this range—the costs range from $9.8 million for 5 sets to $27.3 million for 14 sets (with OSHA's estimate of $15.6 million for 8 sets between the two ends). As discussed under the heading "Economic Feasibility and Impacts," later in this section of the preamble, costs must increase substantially beyond this range to raise an issue regarding economic feasibility.

TABLE 41—ANNUALIZED COSTS ASSOCIATED WITH PROVIDING FLAME-RESISTANT CLOTHING

Industry code	Industry name	Employees affected (%)	Compliance rates (%)	Sets of FRC provided per employee	Cost per set of FRC	Useful life of FRC with 8 sets/employee (years)	Annualized compliance costs
NAICS 234910	Water, Sewer, and Pipeline Construction	100	50/50/75/75	8	$191.75	4	$176,836
NAICS 234920	Power and Communication Transmission Line Construction.	100	50/50/75/75	8	191.75	4	4,623,876
NAICS 234930	Industrial Nonbuilding Structure Construction.	100	50/50/75/75	8	191.75	4	211,993
NAICS 234990	All Other Heavy Construction	100	50/50/75/75	8	191.75	4	1,115,554
NAICS 235310	Electrical Contractors	100	50/50/75/75	8	191.75	4	3,388,729
NAICS 235910	Structural Steel Erection Contractors	100	50/50/75/75	8	191.75	4	57,243
NAICS 235950	Building Equipment and Other Machine Installation Contractors.	100	50/50/75/75	8	191.75	4	53,637
NAICS 235990	All Other Special Trade Contractors	100	50/50/75/75	8	191.75	4	170,375
NAICS 221110	Electric Power Generation	100	80/80/90/90	8	191.75	4	1,719,508
NAICS 221120	Electric Power Transmission, Control, and Distribution.	100	80/80/90/90	8	191.75	4	2,923,654
NAICS 2211	Major Publicly Owned Utilities	100	80/90	8	191.75	4	392,232
Various	Industrial Power Generators	100	90	8	191.75	4	786,729
SIC 0783	Ornamental Shrub and Tree Services	NA	NA	NA	NA	NA	NA
Total							15,620,365

Notes: (1) Totals may not equal the sum of the components due to rounding.
(2) "NA" = Not Applicable.
(3) For most NAICSs, compliance rates are for small unionized establishments, small nonunionized establishments, large unionized establishments, and large nonunionized establishments, respectively. Major Publicly Owned Utilities (NAICS 2211) and Ornamental Shrub and Tree Services (SIC 0783) only have compliance rates for small and large establishments, and Industrial Power Generators only have a compliance rate for large establishments.
Sources: CONSAD [5], Grainger [13], U.S. Census [43, 44, 45, 46].

TABLE 42—ANNUALIZED COSTS ASSOCIATED WITH PROVIDING SWITCHING COATS OR FLASH SUITS

Industry code	Industry name	Employees affected (%)	Compliance rates (%)	Switching coat or flash suit per employee	Cost per switching coat or flash suit	Useful life of switching coat or flash suit (years)	Annualized compliance costs
NAICS 234910	Water, Sewer, and Pipeline Construction	100	50/50/75/75	0.33	$226.00	10	$4,146
NAICS 234920	Power and Communication Transmission Line Construction.	100	50/50/75/75	0.33	226.00	10	108,414
NAICS 234930	Industrial Nonbuilding Structure Construction.	100	50/50/75/75	0.33	226.00	10	4,971
NAICS 234990	All Other Heavy Construction	100	50/50/75/75	0.33	226.00	10	26,156
NAICS 235310	Electrical Contractors	100	50/50/75/75	0.33	226.00	10	79,454
NAICS 235910	Structural Steel Erection Contractors	100	50/50/75/75	0.33	226.00	10	1,342
NAICS 235950	Building Equipment and Other Machine Installation Contractors.	100	50/50/75/75	0.33	226.00	10	1,258
NAICS 235990	All Other Special Trade Contractors	100	50/50/75/75	0.33	226.00	10	3,995
NAICS 221110	Electric Power Generation	100	80/80/90/90	0.33	226.00	10	40,317
NAICS 221120	Electric Power Transmission, Control, and Distribution.	100	80/80/90/90	0.33	226.00	10	68,550
NAICS 2211	Major Publicly Owned Utilities	100	80/90	0.33	226.00	10	9,197
Various	Industrial Power Generators	100	90	0.33	226.00	10	18,446
SIC 0783	Ornamental Shrub and Tree Services	NA	NA	NA	NA	NA	NA
Total							366,245

Notes: (1) Totals may not equal the sum of the components due to rounding.
(2) "NA" = Not Applicable.
(3) For most NAICSs, compliance rates are for small unionized establishments, small nonunionized establishments, large unionized establishments, and large nonunionized establishments, respectively. Major Publicly Owned Utilities (NAICS 2211) and Ornamental Shrub and Tree Services (SIC 0783) only have compliance rates for small and large establishments, and Industrial Power Generators only have a compliance rate for large establishments.
Sources: CONSAD [5], Lab Safety Supply [18], U.S. Census [43, 44, 45, 46].

TABLE 43—ANNUALIZED COSTS ASSOCIATED WITH PROVIDING ARC-RATED FACESHIELD FOR ELECTRICAL POWER-LINE INSTALLERS AND REPAIRERS

Industry code	Industry name	Employees affected (%)	Cost per faceshield	Useful life of faceshield (years)	Compliance rate (%)	Annualized compliance costs
NAICS 234910	Water, Sewer, and Pipeline Construction	0	NA	2	NA	NA
NAICS 234920	Power and Communication Transmission Line Construction.	13	$86.50	2	0/0/0/0	$216,130
NAICS 234930	Industrial Nonbuilding Structure Construction	0	NA	NA	NA	NA
NAICS 234990	All Other Heavy Construction	0	NA	NA	NA	NA
NAICS 235310	Electrical Contractors	0	NA	NA	NA	NA
NAICS 235910	Structural Steel Erection Contractors	0	NA	NA	NA	NA
NAICS 235950	Building Equipment and Other Machine Installation Contractors.	0	NA	NA	NA	NA
NAICS 235990	All Other Special Trade Contractors	0	NA	NA	NA	NA
NAICS 221110	Electric Power Generation	13	86.50	2	0/0/0/0	233,674
NAICS 221120	Electric Power Transmission, Control, and Distribution.	13	86.50	2	0/0/0/0	399,296
NAICS 2211	Major Publicly Owned Utilities	13	86.50	2	0/0	53,391
Various	Industrial Power Generators	0	NA	NA	NA	NA
SIC 0783	Ornamental Shrub and Tree Services	0	NA	NA	NA	NA
Total						902,492

Notes: (1) Totals may not equal the sum of the components due to rounding.
(2) "NA" = Not Applicable.
(3) For most NAICSs, compliance rates are for small unionized establishments, small nonunionized establishments, large unionized establishments, and large nonunionized establishments, respectively. Major Publicly Owned Utilities (NAICS 2211) and Ornamental Shrub and Tree Services (SIC 0783) only have compliance rates for small and large establishments, and Industrial Power Generators only have a compliance rate for large establishments.
Sources: BLS [39, 40], Grainger [11], U.S. Census [43, 44, 45, 46].

TABLE 44—ANNUALIZED COSTS ASSOCIATED WITH PROVIDING ARC-RATED FACESHIELD FOR ELECTRICAL AND ELECTRONICS REPAIRERS WORKING IN GENERATING STATIONS, SUBSTATIONS, AND IN-SERVICE RELAYS

Industry code	Industry name	Employees affected (%)	Cost per faceshield	Useful life of faceshield (years)	Compliance rate (%)	Annualized compliance costs
NAICS 234910	Water, Sewer, and Pipeline Construction	0	NA	NA	NA	NA
NAICS 234920	Power and Communication Transmission Line Construction.	4	$86.50	2	50/50/75/75	$21,289
NAICS 234930	Industrial Nonbuilding Structure Construction	0	NA	NA	NA	NA
NAICS 234990	All Other Heavy Construction	0	NA	NA	NA	NA
NAICS 235310	Electrical Contractors	0	NA	NA	NA	NA
NAICS 235910	Structural Steel Erection Contractors	0	NA	NA	NA	NA
NAICS 235950	Building Equipment and Other Machine Installation Contractors.	0	NA	NA	NA	NA
NAICS 235990	All Other Special Trade Contractors	0	NA	NA	NA	NA
NAICS 221110	Electric Power Generation	4	86.50	2	80/80/90/90	7,917
NAICS 221120	Electric Power Transmission, Control, and Distribution.	4	86.50	2	80/80/90/90	13,461
NAICS 2211	Major Publicly Owned Utilities	4	86.50	2	80/90	1,806
Various	Industrial Power Generators	0	NA	NA	NA	NA
SIC 0783	Ornamental Shrub and Tree Services	0	NA	NA	NA	NA
Total						44,472

Notes: (1) Totals may not equal the sum of the components due to rounding.
(2) "NA" = Not Applicable.
(3) For most NAICSs, compliance rates are for small unionized establishments, small nonunionized establishments, large unionized establishments, and large nonunionized establishments, respectively. Major Publicly Owned Utilities (NAICS 2211) and Ornamental Shrub and Tree Services (SIC 0783) only have compliance rates for small and large establishments, and Industrial Power Generators only have a compliance rate for large establishments.
Sources: BLS [40, 41], Grainger [11], U.S. Census [43, 44, 45, 46].

TABLE 45—ANNUALIZED COSTS ASSOCIATED WITH PROVIDING ARC-RATED HEAD PROTECTION FOR ELECTRICAL POWER-LINE INSTALLERS AND REPAIRERS

Industry code	Industry name	Employees affected (%)	Cost per balaclava	Useful life of balaclava (years)	Compliance rate (%)	Annualized compliance costs
NAICS 234910	Water, Sewer, and Pipeline Construction	0	NA	NA	NA	NA
NAICS 234920	Power and Communication Transmission Line Construction.	13	$29.75	2	0/0/0/0	$74,334

TABLE 45—ANNUALIZED COSTS ASSOCIATED WITH PROVIDING ARC-RATED HEAD PROTECTION FOR ELECTRICAL POWER-LINE INSTALLERS AND REPAIRERS—Continued

Industry code	Industry name	Employees affected (%)	Cost per balaclava	Useful life of balaclava (years)	Compliance rate (%)	Annualized compliance costs
NAICS 234930	Industrial Nonbuilding Structure Construction	0	NA	NA	NA	NA
NAICS 234990	All Other Heavy Construction	0	NA	NA	NA	NA
NAICS 235310	Electrical Contractors	0	NA	NA	NA	NA
NAICS 235910	Structural Steel Erection Contractors	0	NA	NA	NA	NA
NAICS 235950	Building Equipment and Other Machine Installation Contractors.	0	NA	NA	NA	NA
NAICS 235990	All Other Special Trade Contractors	0	NA	NA	NA	NA
NAICS 221110	Electric Power Generation	13	29.75	2	0/0/0/0	80,368
NAICS 221120	Electric Power Transmission, Control, and Distribution.	13	29.75	2	0/0/0/0	137,330
NAICS 2211	Major Publicly Owned Utilities	13	29.75	2	0/0	18,363
Various	Industrial Power Generators	0	NA	NA	NA	NA
SIC 0783	Ornamental Shrub and Tree Services	0	NA	NA	NA	NA
Total						310,395

Notes: (1) Totals may not equal the sum of the components due to rounding.
(2) "NA" = Not Applicable.
(3) For most NAICSs, compliance rates are for small unionized establishments, small nonunionized establishments, large unionized establishments, and large nonunionized establishments. respectively. Major Publicly Owned Utilities (NAICS 2211) and Ornamental Shrub and Tree Services (SIC 0783) only have compliance rates for small and large establishments, and Industrial Power Generators only have a compliance rate for large establishments.
Sources: BLS [39, 40], Grainger [12], U.S. Census [43, 44, 45, 46].

TABLE 46—ANNUALIZED ASSOCIATED WITH PROVIDING ARC-RATED HEAD PROTECTION FOR ELECTRICAL AND ELECTRONICS REPAIRERS WORKING IN GENERATING STATIONS, SUBSTATIONS, AND IN-SERVICE RELAYS

Industry code	Industry name	Employees affected (%)	Cost per balaclava	Useful life of balaclava (years)	Compliance rate (%)	Annualized compliance costs
NAICS 234910	Water, Sewer, and Pipeline Construction	0	NA	NA	NA	NA
NAICS 234920	Power and Communication Transmission Line Construction.	4	$29.75	2	50/50/75/75	$7,322
NAICS 234930	Industrial Nonbuilding Structure Construction	0	NA	NA	NA	NA
NAICS 234990	All Other Heavy Construction	0	NA	NA	NA	NA
NAICS 235310	Electrical Contractors	0	NA	NA	NA	NA
NAICS 235910	Structural Steel Erection Contractors	0	NA	NA	NA	NA
NAICS 235950	Building Equipment and Other Machine Installation Contractors.	0	NA	NA	NA	NA
NAICS 235990	All Other Special Trade Contractors	0	NA	NA	NA	NA
NAICS 221110	Electric Power Generation	4	29.75	2	80/80/90/90	2,723
NAICS 221120	Electric Power Transmission, Control, and Distribution.	4	29.75	2	80/80/90/90	4,630
NAICS 2211	Major Publicly Owned Utilities	4	29.75	2	80/90	621
Various	Industrial Power Generators	0	NA	NA	NA	NA
SIC 0783	Ornamental Shrub and Tree Services	0	NA	NA	NA	NA
Total						15,295

Notes: (1) Totals may not equal the sum of the components due to rounding.
(2) "NA" = Not Applicable.
(3) For most NAICSs, compliance rates are for small unionized establishments, small nonunionized establishments, large unionized establishments, and large nonunionized establishments, respectively. Major Publicly Owned Utilities (NAICS 2211) and Ornamental Shrub and Tree Services (SIC 0783) only have compliance rates for small and large establishments, and Industrial Power Generators only have a compliance rate for large establishments.
Sources: BLS [40, 41], Grainger [12], U.S. Census [43, 44, 45, 46].

12. Annual Costs for Providing Harnesses for Fall Arrest in Aerial Lifts

Under the final rule, employees in aerial lifts performing work covered by § 1910.269 will no longer be able to use body belts as part of fall arrest systems and instead must use harnesses. However, OSHA estimates that while the final rule affects employees of construction contractors or utilities, employers in these industries are in 100-percent compliance with the final rule. Employers already must use harnesses for equivalent work in construction (see § 1926.502(d) and the discussion of final § 1926.954(b) in Section V, Summary and Explanation of the Final Rule, earlier in this preamble), and employers in these industries perform construction work. Moreover, research conducted by CONSAD reveals that establishments in these industries already provide employees with harnesses as required by the final rule [5]. (To simplify analysis, Table 47 treats the costs for all industries other than Industrial Power Generators and Ornamental Shrub and Tree Services as not applicable.)

OSHA estimates that employers in the Industrial Power Generators and Ornamental Shrub and Tree Services industries will incur costs under the final rule. OSHA bases its cost estimates on CONSAD's finding that, unlike the other industries, a substantial portion of establishments in the Industrial Power Generators and Ornamental Shrub and Tree Services industries do not provide their workers with harnesses [5].[565]

For employers in the Industrial Power Generators industry, the harness provisions would affect an estimated 67 percent of the employees who perform electric power generation, transmission, and distribution work [5]. Among employees in the Ornamental Shrub and Tree Services industry who perform line-clearance tree-trimming operations, these provisions affect an estimated 50 percent of the workforce (*id.*).

OSHA estimated the rates of current compliance with the final requirements for each affected industry. The Agency estimated the average rate of compliance currently among employers in the Industrial Power Generators industry, which have employees potentially affected by the final rule, to be 75 percent. Similarly, among employees performing line-clearance tree-trimming operations, OSHA estimated current compliance to be 25 percent for establishments with fewer than 20 employees and 50 percent for establishments with 20 or more employees [5]. OSHA concludes that this estimate is reasonable. While one commenter questioned this estimate for line-clearance tree trimmers (Ex. 0174), another commenter confirmed that it was generally accurate (Ex. 0419).

The Agency estimated the average cost associated with providing a harness instead of a body belt to be about $69 per affected employee [19, 20].[566] When OSHA annualized the costs of compliance for providing harnesses for fall arrest in aerial lifts at a 7-percent interest rate over the useful life of the equipment (5 years), the resulting total estimated annualized cost is approximately $0.1 million, as shown in Table 47. Table 47 also shows the costs of compliance for each affected industry.

While one commenter indicated that the cost would be several times larger than OSHA estimated, the commenter failed to annualize the costs associated with providing harnesses (Ex. 0174). The commenter also failed to account for the manner in which OSHA estimated the percentage of employees affected, that is, by excluding from the percentage of employees affected employees who do not work from aerial lifts and affected employees who must wear harnesses as the existing construction standard requires.

TABLE 47—ANNUALIZED COSTS FOR PROVIDING HARNESSES FOR FALL ARREST IN AERIAL LIFTS

Industry code	Industry name	Employees affected (%)	Incremental cost of harness in lieu of belt	Useful life of harness (years)	Compliance rates (%)	Annualized compliance costs
NAICS 234910 ..	Water, Sewer, and Pipeline Construction.	0	NA	NA	NA	NA
NAICS 234920 ..	Power and Communication Transmission Line Construction.	0	NA	NA	NA	NA
NAICS 234930 ..	Industrial Nonbuilding Structure Construction.	0	NA	NA	NA	NA
NAICS 234990 ..	All Other Heavy Construction	0	NA	NA	NA	NA
NAICS 235310 ..	Electrical Contractors	0	NA	NA	NA	NA
NAICS 235910 ..	Structural Steel Erection Contractors	0	NA	NA	NA	NA
NAICS 235950 ..	Building Equipment and Other Machine Installation Contractors.	0	NA	NA	NA	NA
NAICS 235990 ..	All Other Special Trade Contractors	0	NA	NA	NA	NA
NAICS 221110 ..	Electric Power Generation	0	NA	NA	NA	NA
NAICS 221120 ..	Electric Power Transmission, Control, and Distribution.	0	NA	NA	NA	NA
NAICS 2211	Major Publicly Owned Utilities	0	NA	NA	NA	NA
Various	Industrial Power Generators	67	$69	5	75	$48,612
SIC 0783	Ornamental Shrub and Tree Services ..	50	69	5	25/50	64,610
Total	.....	.....	.....	.....	.....	113,222

Notes: (1) Totals may not equal the sum of the components due to rounding.
(2) "NA" = Not Applicable.
(3) Ornamental Shrub and Tree Services (SIC 0783) only have compliance rates for small and large establishments, and Industrial Power Generators only have a compliance rate for large establishments.
Sources: CONSAD [5], Lab Safety Supply [19, 20], U.S. Census [43, 44, 45, 46].

[565] This estimate may be an overestimate. First, the pattern of providing harnesses to employees may now differ from what CONSAD observed in 2005. Second, as explained earlier in this analysis, since repair or maintenance work and construction work are often identical, companies are not likely to restrict themselves to only repair or maintenance work, or to only construction work, with regard to potential jobs involving electric power generation, transmission, and distribution. Therefore, employers that are in the Industrial Power Generators industry, that perform construction work, and that are not providing harnesses to their employees may simply be out of compliance with the existing construction requirement. OSHA's analysis assumes that employers in the Ornamental Shrub and Tree Services industry do not perform construction work. To the extent that these employees do perform construction work, as during site-clearing operations, § 1926.502(d) currently requires harnesses when employees are performing this work from aerial lifts. Consequently, OSHA estimates of current compliance in this industry also should be conservative.

[566] In the PRIA, OSHA estimated that the average cost associated with providing a harness instead of a belt was about $100 per affected employee (70 FR 34917). OSHA's new estimate reflects data showing that the cost differential between harnesses and belts fell between the time of the PRIA and the FEA.

13. Costs for Upgrading Fall Protection Equipment

An additional cost for fall protection equipment that OSHA did not include in the analysis of the proposed rule is the cost of upgrading fall protection equipment for line workers in the affected industries. Paragraph (b)(3)(iv) of final § 1926.954 requires that employers ensure that employees rig work-positioning systems so that the employee can free fall not more than 0.6 meters (2 feet). Paragraph (b)(3)(v) of final § 1926.954 requires that anchorages for work-positioning equipment be capable of supporting at least twice the potential impact load of an employee's fall, or 13.3 kilonewtons (3,000 pounds-force), whichever is greater. Paragraph (b)(3)(iii)(C) of final § 1926.954 provides that, on and after April 1, 2015, employers must ensure that qualified employees climbing or changing location on poles, towers, or similar structures use fall protection 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 fall protection. Therefore, these three provisions, as explained in the discussion of final § 1926.954(b)(3) in Section V, Summary and Explanation of the Final Rule, earlier in this preamble, require replacement of most positioning straps and lanyards currently in use. To estimate the number of line workers affected by these provisions, OSHA calculated the percentage of line installers and repairers in NAICS 221100—Electric Power Generation, Transmission and Distribution from the number of line installers and repairers (that is, 51,440) and the total employment (that is, 402,840) in that industry [37, 38] and assumed that this percentage (that is, 13 percent) was similar across all affected NAICSs. Based on publicly available information from vendors of electrical protective equipment, OSHA estimates that positioning straps cost approximately $200 [4].[567] Estimating a compliance rate of 50 percent across all industries[568] and annualizing the cost of the positioning straps over a 5-year useful life, results in estimated annualized compliance costs of approximately $0.5 million, as shown in Table 48. Table 48 also shows the costs of compliance for each affected industry.

TABLE 48—ANNUALIZED COSTS FOR UPGRADING FALL PROTECTION EQUIPMENT

Industry code	Industry name	Employees affected (%)	Cost of positioning straps	Useful life of positioning strap (years)	Compliance rate (%)	Annualized compliance costs
NAICS 234910 ..	Water, Sewer, and Pipeline Construction.	NA	NA	NA	NA	NA
NAICS 234920 ..	Power and Communication Transmission Line Construction.	13	$200	5	50/50/50/50	$108,190
NAICS 234930 ..	Industrial Nonbuilding Structure Construction.	NA	NA	NA	NA	NA
NAICS 234990 ..	All Other Heavy Construction	NA	NA	NA	NA	NA
NAICS 235310 ..	Electrical Contractors	NA	NA	NA	NA	NA
NAICS 235910 ..	Structural Steel Erection Contractors	NA	NA	NA	NA	NA
NAICS 235950 ..	Building Equipment and Other Machine Installation Contractors.	NA	NA	NA	NA	NA
NAICS 235990 ..	All Other Special Trade Contractors	NA	NA	NA	NA	NA
NAICS 221110 ..	Electric Power Generation	13	200	5	50/50/50/50	116,972
NAICS 221120 ..	Electric Power Transmission, Control, and Distribution.	13	200	5	50/50/50/50	199,879
NAICS 2211	Major Publicly Owned Utilities	13	200	5	50/50	26,727
Various	Industrial Power Generators	NA	NA	NA	NA	NA
SIC 0783	Ornamental Shrub and Tree Services ..	NA	NA	NA	NA	NA
Total						451,768

Notes: (1) Totals may not equal the sum of the components due to rounding.
(2) "NA" = Not Applicable.
(3) For most NAICSs, compliance rates are for small unionized establishments, small nonunionized establishments, large unionized establishments, and large nonunionized establishments, respectively. Major Publicly Owned Utilities (NAICS 2211) and Ornamental Shrub and Tree Services (SIC 0783) only have compliance rates for small and large establishments, and Industrial Power Generators only have a compliance rate for large establishments.
Sources: Buckingham Manufacturing [4], U.S. Census [43, 44, 45, 46].

[567] The final rule generally gives employers the option of using different types of fall protection equipment. OSHA estimated costs for replacing positioning straps only and did not estimate costs associated with using other types of fall protection required by the relevant provisions of the final rule. OSHA believes that the cost of replacing positioning straps (per employee) is representative of the per-employee cost for any type of fall protection. In any event, employees can and do use work-positioning equipment in the vast majority of applicable cases. OSHA also assumed that, on average, employers need purchase only one type of fall protection for each affected worker. OSHA believes this is a valid assumption. On the one hand, the fall protection requirements at issue will not require employers to provide fall protection to qualified employees, such as underground power line workers, who do not climb or change location on poles, towers, or similar structures. On the other hand, some employers will need to provide different types of fall protection to some line workers who work on multiple types of structures.

[568] Comments to the record suggested that, as of 2005, compliance with this provision was common, but less than universal (Ex. 0230; Tr. 1357). The Agency believes that compliance with the provision has become more widespread in the interim, in part because the Agency already requires attachment under certain circumstances. Therefore, the estimate of 50-percent current compliance likely is conservative.

14. Costs Related to Minimum Approach Distances

The final rule contains provisions related to the calculation of minimum approach distances that are new to both § 1910.269 and Subpart V. The final rule is more protective and more technologically sound than the existing standards; in some cases the final rule will require employers to either perform an engineering analysis or use portable protective gaps to ensure implementation of the required minimum approach distance.

To calculate the cost of these provisions, OSHA first determined the number of potentially affected entities by estimating the number of utilities performing transmission work.[569] The Census' NAICS categories used elsewhere in this analysis do not differentiate between utilities performing transmission work and utilities performing generation or distribution work, so OSHA used data from the Department of Energy to estimate the number of utilities performing transmission work. The Department of Energy's U.S. Energy Information Administration Form EIA–861 Final Data File for 2008 [50] suggests that there are approximately 623 utilities performing transmission work. Of these utilities, 6 utilities list 0 sales, and 105 are missing sales data. Of the remaining 512 utilities with sales data, 265 (52 percent) are small businesses by SBA standards [51], with sales of less than 4 million megawatt-hours annually. The remaining 247 (48 percent) are large businesses, with sales of over 4 million megawatt-hours annually.

OSHA next estimated the percentage of utilities performing transmission work that have lines operating at voltages of 230 kilovolts or more. Recent data on publicly owned utilities are not available because EIA terminated its Form EIA–412 database of annual electric industry financial reports from publicly owned utilities in 2005. However, a similar database of investor-owned utilities is available from the Federal Energy Regulatory Commission's *Form No. 1: Annual Report of Major Electric Utilities* [10]. ERG downloaded transmission-line statistics for a random selection of investor-owned utilities that perform transmission work and analyzed the operational voltage for all of their transmission lines. ERG found that 28 percent of these utilities had transmission lines with operational voltages of at least 230 kilovolts. ERG then applied this percentage to all publicly owned and investor-owned utilities performing transmission work. This approach found that 143 utilities performing transmission work have transmission lines operating at these voltages and, thus, will incur costs related to MAD [8].

OSHA estimates that these 143 affected utilities will calculate the maximum anticipated transient overvoltage (that is, *T*) on their systems to determine appropriate minimum approach distances. OSHA estimated costs based on 4 engineering hours for small utilities and 8 engineering hours for large utilities to perform this calculation [8]. This approach results in total estimated labor costs of $26,097. When annualized at a rate of 7 percent over 10 years, this approach results in total estimated costs of $6,286 (see Table 49).

Some commenters, such as EEI (Ex. 0575.1), expressed concern that substantially increased minimum approach distances would require the purchase of additional hardware, such as aerial lifts with longer booms, or possibly result in more scheduled outages.

As discussed in depth in the discussion of final § 1926.960(c)(1) in Section V, Summary and Explanation of the Final Rule, earlier in this preamble, the Agency believes that the regulated community can largely avoid these costs. In some cases, however, after performing the engineering analysis, utilities may find that they are not able to perform work in accordance with the minimum approach distances required by the final rule without using portable protective gaps to reduce the maximum per-unit transient overvoltage on a line.[570] OSHA estimated that this impact will occur for 10 percent of the 143 affected utilities, or 14 utilities [8]. Each of these 14 utilities will incur fixed costs of approximately $25,000 to design and test the portable protective gaps, regardless of how many portable protective gaps they use (*id.*). The portable protective gaps will cost approximately $5,000, and OSHA estimates that each affected utility will purchase 24 portable protective gaps, resulting in total costs for portable protective gaps of approximately $2.1 million (*id.*). When annualized at a rate of 7 percent over 10 years, the estimated costs are approximately $0.3 million (see Table 49).

Finally, utilities will incur costs to install the portable protective gaps on affected projects. OSHA estimated the number of projects performed per year by the 143 affected utilities performing transmission work by calculating the ratio of affected utilities to total firms in the Electric Power Transmission, Control, and Distribution (NAICS 221120) and Major Publicly Owned Utilities (NAICS 2211) categories (see Table 19). Applying this ratio (approximately 0.095) to the total number of projects for all firms in these two industries (see Table 38) results in a total of 289,824 projects for the affected firms. With an estimated 10 percent of these projects using portable protective gaps, the total number of affected projects is 28,982.[571] The number of portable protective gaps used per project, and the time it will take to install each portable protective gap, will vary depending on the number of phase conductors and the voltage of the lines. OSHA estimates that, on average, it will take a crew of two individuals using an aerial lift half an hour per project to install the appropriate number of portable protective gaps, resulting in estimated total annual labor costs for the 14 affected utilities of approximately $1.5 million, as shown in Table 49. (Note that this analysis conservatively assumes that no firms currently employ portable protective gaps.)

[569] For reasons explained in the summary and explanation of final § 1926.960(c)(1), in Section V, Summary and Explanation of the Final Rule, earlier in this preamble, the Agency believes that the final rule will have a substantial effect only on transmission work involving voltages of 230 kilovolts or more. Utilities use portable protective gaps to reduce the maximum transient overvoltage on a line (and thereby reduce the required minimum approach distance). According to ERG, electric utilities perform most of the affected work themselves [8]. Accounting for this factor, OSHA's analysis assumes that contractors will not be using portable protective gaps to achieve reduced minimum approach distances. In any event, given the small amount of relevant work performed by contractors, any costs for portable protective gaps borne by contractors will be negligible.

As with other provisions of the standard, the Agency made a reasonable estimate of whether the contractor or the utility would immediately bear the cost of this requirement. The Agency expects that, to the extent that contractors incur this cost, utilities ultimately will bear it, as contracts between contractors and utilities will most likely pass through the cost to utilities. Moreover, to the extent the Agency overallocated cost estimates directly to the utility sector, it should not affect questions of economic feasibility.

[570] See the summary and explanation for final § 1926.960(c)(1)(i), in Section V, Summary and Explanation of the Final Rule, earlier in this preamble, for a discussion of how employers will comply with increased minimum approach distances.

[571] ERG estimated that utilities in dense urban areas use portable protective gaps about 10 percent of the time and that they normally use portable protective gaps on compact design lines found in major population areas [8]. Since utilities are less likely to use portable protective gags in nonurban areas, the 10-percent statistic is a conservative measure of the extent of portable-protective-gap use among all utilities with high-voltage transmission lines (*id.*).

Summing the annualized costs for utilities to calculate the maximum anticipated transient overvoltage and to purchase and install portable protective gaps results in an estimated total cost of approximately $1.8 million for the new minimum approach-distance requirements in the final rule, as shown in Table 49.

TABLE 49—ANNUALIZED COSTS FOR CALCULATING NEW MADS AND USING PORTABLE PROTECTIVE GAPS

Industry code	Industry name	Share of power projects (%)	Affected utilities	Annualized one-time engineering cost	Annualized PPG capital costs	Annual PPG installation costs	Total annualized costs
NAICS 221120 ..	Electric Power Transmission, Control, and Distribution.	88.2	126	$5,542	$260,953	$1,327,197	$1,593,692
NAICS 2211	Major Publicly Owned Utilities.	11.8	17	744	35,010	178,059	213,812
Total	.....	.....	143	6,286	295,963	1,505,256	1,807,505

Note: Totals may not equal the sum of the components due to rounding.
Sources: BLS [36, 37], CONSAD [5], EIA [49], ERG [8], FERC [10], SBA [51].

15. First-Year Costs

The first-year nonnegligible costs for the final rule include unannualized capital costs, unannualized costs for other one-time expenses (such as the cost of revising training programs), and any annual costs borne in the first year. In the case of training, first-year costs include one-time costs for revising training programs, one-time costs for providing additional training to employees already receiving training in accordance with existing § 1910.269, one-time costs for additional training for employees not already receiving training in accordance with existing § 1910.269, and one-time costs for training in the use of fall protection for qualified employees. First-year costs also include one-time costs for the arc-hazard assessment (but not the annual cost of updating the assessment), the costs of providing appropriate arc-flash protective equipment (including flame-resistant clothing, switching coats and flash suits, head protection, and face protection), the cost of providing harnesses for fall arrest for employees working from aerial lifts, the cost of upgrading fall protection equipment, one-time engineering costs for calculating new minimum approach distances, and capital costs for portable-protective-gaps. Finally, first-year costs include the first year's annual costs for installing portable protective gaps, the first year's annual costs for host-contractor communication, the first year's annual costs for job briefings, and the first year's annual costs of complying with existing § 1910.269 (other than training) for employees not already covered by § 1910.269. These first year costs total $113.8 million and are summarized in Table 50.

TABLE 50—FIRST YEAR COSTS

Industry code	Industry name	Training	Host-contractor communication	Job briefing	Other costs for employees not already covered by § 1910.269	Calculating incident energy and arc-hazard assessment (arc-hazard assessment)
NAICS 234910 ..	Water, Sewer, and Pipeline Construction.	$240,468	$150,214	$70,743	$4,427	NA
NAICS 234920 ..	Power and Communication Transmission Line Construction.	5,670,126	1,891,463	1,777,657	121,855	NA
NAICS 234930 ..	Industrial Nonbuilding Structure Construction.	22,591	204,286	70,999	NA	NA
NAICS 234990 ..	All Other Heavy Construction	1,132,361	894,356	424,921	25,941	NA
NAICS 235310 ..	Electrical Contractors	3,519,375	2,702,235	1,545,162	76,067	NA
NAICS 235910 ..	Structural Steel Erection Contractors ...	39,624	47,763	24,717	NA	NA
NAICS 235950 ..	Building Equipment and Other Machine Installation Contractors.	57,131	44,957	23,197	NA	NA
NAICS 235990 ..	All Other Special Trade Contractors	163,570	124,535	71,957	NA	NA
NAICS 221110 ..	Electric Power Generation	207,776	2,397,541	675,284	NA	1,910,206
NAICS 221120 ..	Electric Power Transmission, Control, and Distribution.	383,402	6,393,786	1,144,815	NA	4,547,557
NAICS 2211	Major Publicly Owned Utilities	51,589	571,626	153,887	NA	1,126,003
Various	Industrial Power Generators	33,561	648,391	306,992	NA	862,483
SIC 0783	Ornamental Shrub and Tree Services ..	114,631	1,749,688	407,227	NA	NA
Total	.....	11,636,205	17,820,841	6,697,557	228,289	8,446,249

TABLE 50—FIRST YEAR COSTS (CONTINUED)

Industry code	Industry name	Provision of appropriate arc-flash protective equipment	Use of harnesses in aerial lifts	Upgrading fall protection equipment	MAD	Total first year compliance costs
NAICS 234910 ..	Water, Sewer, and Pipeline Construction.	$687,227	NA	NA	NA	$1,153,078
NAICS 234920 ..	Power and Communication Transmission Line Construction.	18,546,383	NA	443,601	NA	28,451,085
NAICS 234930 ..	Industrial Nonbuilding Structure Construction.	823,855	NA	NA	NA	1,121,731
NAICS 234990 ..	All Other Heavy Construction	4,335,309	NA	NA	NA	6,812,888
NAICS 235310 ..	Electrical Contractors	13,169,413	NA	NA	NA	21,012,253
NAICS 235910 ..	Structural Steel Erection Contractors	222,458	NA	NA	NA	334,562
NAICS 235950 ..	Building Equipment and Other Machine Installation Contractors.	208,445	NA	NA	NA	333,729
NAICS 235990 ..	All Other Special Trade Contractors	662,120	NA	NA	NA	1,022,182
NAICS 221110 ..	Electric Power Generation	7,269,449	NA	479,610	NA	12,939,866
NAICS 221120 ..	Electric Power Transmission, Control, and Distribution.	12,364,959	NA	819,545	3,198,950	28,853,013
NAICS 2211	Major Publicly Owned Utilities	1,658,430	NA	109,585	429,176	4,100,296
Various	Industrial Power Generators	3,057,416	199,318	NA	NA	5,108,161
SIC 0783	Ornamental Shrub and Tree Services ..	0	264,915	NA	NA	2,536,461
Total	.....	63,005,465	464,233	1,852,340	3,628,126	113,779,305

Notes: (1) Totals may not equal the sum of the components due to rounding.
(2) "NA" = Not Applicable.
Sources: Office of Regulatory Analysis, OSHA (see text).

16. *Economic Feasibility and Impacts*

This portion of the analysis presents OSHA's analysis of the economic impacts of the final rule and an assessment of the economic feasibility of compliance with the requirements imposed by the rulemaking. To assess the types and magnitude of the economic impacts associated with compliance with the final rule, OSHA developed quantitative estimates of the economic impact of the requirements on entities in each of the affected industries. OSHA compared the estimated costs of compliance presented previously in this economic analysis with industry revenues and profits to provide an assessment of potential economic impacts. (Following the assessment of potential economic impacts, OSHA presents a separate analysis of the economic impacts of the final rule on small entities as part of the Final Regulatory Flexibility Analysis.)

Table 51 presents data on the revenues for each affected industry, along with the corresponding industry profits and the estimated costs of compliance in each industry. For the FEA, OSHA updated revenue data for the 1997 NAICS and SIC categories used in the CONSAD analysis using the U.S. Census Bureau's 1997 NAICS and 1987 SIC Correspondence Tables [44], the 1997 NAICS to 2002 NAICS Correspondence Tables [45], and the 2002 NAICS to 2007 NAICS Correspondence Tables [46]. As explained earlier in this FEA, in many cases, a single 1997 NAICS code maps to multiple 2007 NAICS codes (see the discussion under the heading "Profile of Affected Industries"). Revenue data is drawn from the U.S. Census' Statistics of U.S. Businesses [43]. In most cases, once OSHA matched a 1997 category with its corresponding 2007 categories, OSHA averaged revenue for the 2007 NAICS categories to produce a single updated estimate for the 1997 NAICS category. In the case of Electric Power Generation (1997 NAICS 221110) and Electric Power Transmission, Control, and Distribution (1997 NAICS 221120), however, the updated estimates for the respective 1997 NAICS categories are the sum of the corresponding 2007 NAICS categories. After updating the revenue data, OSHA calculated the average revenue per establishment for each 1997 NAICS or SIC category by dividing the updated data for each category by the updated estimate of total establishments in each 1997 category. Then, to estimate the weighted average revenues and profits for affected establishments, OSHA multiplied the revenue per establishment by the updated estimate of affected establishments in each 1997 NAICS category [572] (see Table 19).

Generally, the Agency assumed that the revenue profiles of affected establishments mirrored the profiles of the other establishments in the designated NAICS codes. However, CONSAD's industry profile evidenced significantly larger than average affected establishments for Electrical Contractors (NAICS 235310) and Ornamental Shrub and Tree Services (SIC 0783), as the affected establishments in these two industries had more "power workers" than the average number of employees per establishment for all establishments in those industries. For these two industries, the Agency increased the average revenues by the respective ratios of power workers to total average employees.

In addition, in the case of these two industries, the Agency needed to further adjust the estimated revenue profile to better match the establishments that the final standard would affect. First, the Agency determined that the establishments and firms in the Electrical Contractors industry (NAICS 235310), on average, do only a small portion of their work on electric power installations covered by the final standard. OSHA based this determination, in part, on the NAICS definitions—if the establishments did

[572] In most affected industry sectors, the earlier NAICS code fragmented into several different NAICS codes that would be difficult to reassemble. In the case of the Electric Power Generation (1997 NAICS 221110) and Electric Power Transmission, Control, and Distribution (1997 NAICS 221120) industries, however, the NAICS codes still largely align with their earlier version. For this reason, OSHA estimated revenues for these two industries than for the other affected industries.

most of their work on electric utility systems, the establishments would be in another NAICS code. Moreover, the Agency believes that Electrical Contractors (NAICS 235310) affected by the final rule are different in kind than Electrical Contractors (NAICS 235310) not affected by the final rule, as those affected by the final rule are part of a small minority of specialized firms and establishments in NAICS 235310 that do high-voltage work and are larger and invest in more specialized capital equipment than the typical small electrical contractor (which typically does only low-voltage work in settings such as residential construction). Based on these factors, the Agency assumed that power workers comprise only 25 percent of the typical workforce in establishments that are in the Electrical Contractors industry and that the final rule affects. The Agency also assumed that the relevant revenue figures for these establishments and for firms controlling these establishments would be four times those of the average electrical contractor.

Second, as discussed under the heading "Profile of Affected Industries," earlier in this section of the preamble, the affected establishments in the Ornamental Shrub and Tree Services industry (SIC 0783) are primarily large establishments having 20 or more employees. The size of affected establishment is decidedly different from the average in the industry, which, the Profile of Affected Industries shows, consists mostly of small establishments having fewer than 20 employees. Therefore, to analyze the economic impact for the Ornamental Shrub and Tree Services industry (SIC 0783), the Agency used the projected economic profile of the affected set of establishments, as opposed to that of all establishments, in the industry. (Consistent with this approach, for the analysis of firms with fewer than 20 employees, the analysis incorporated only the information from this small subset of smaller establishments.)

To calculate profit rates, OSHA used data from the Internal Revenue Service's (IRS) Corporation Sourcebook, which contains accounting information for the various industries established by the NAICS system. OSHA calculated profit rates using IRS data for each year from 2000 through 2006 and averaged these rates to produce an average profit rate for each 2007 NAICS. OSHA then averaged the profit rates for each 2007 NAICS to produce an estimate for the profit rate for each of the 1997 NAICS, consistent with the original CONSAD analysis. OSHA then multiplied the updated revenue estimates by the profit rate to determine profits.

TABLE 51—COSTS AS A PERCENT OF REVENUES AND PROFITS FOR AFFECTED ESTABLISHMENTS

Industry code	Industry name	Number of affected est.	Costs per affected est.	Revenues per est.	Profits per est.	Costs as a percent of revenues	Costs as a percent of profits
NAICS 234910 ..	Water, Sewer, and Pipeline Construction.	1,021	$456	$8,513,020	$444,380	0.005	0.103
NAICS 234920 ..	Power and Communication Transmission Line Construction.	3,412	3,086	5,973,947	311,840	0.052	0.990
NAICS 234930 ..	Industrial Nonbuilding Structure Construction.	321	1,544	8,616,909	434,005	0.018	0.356
NAICS 234990 ..	All Other Heavy Construction.	791	3,545	3,426,792	166,062	0.103	2.135
NAICS 235310 ..	Electrical Contractors	1,945	4,438	6,231,556	269,203	0.071	1.648
NAICS 235910 ..	Structural Steel Erection Contractors.	786	174	2,346,498	103,715	0.007	0.168
NAICS 235950 ..	Building Equipment and Other Machine Installation Contractors.	1,148	114	3,463,515	153,087	0.003	0.075
NAICS 235990 ..	All Other Special Trade Contractors.	3,150	125	2,948,895	135,944	0.004	0.092
NAICS 221110 ..	Electric Power Generation.	2,171	2,733	101,021,115	19,113,195	0.003	0.014
NAICS 221120 ..	Electric Power Transmission, Control, and Distribution.	7,440	1,874	44,202,675	4,181,573	0.004	0.045
NAICS 2211	Major Publicly Owned Utilities.	927	1,846	48,441,576	NA	0.004	NA
Various	Industrial Power Generators.	913	2,298	2,819,000	ND	0.082	ND
SIC 0783	Ornamental Shrub and Tree Services.	381	5,867	5,259,031	274,424	0.112	2.138
Total	.....	24,407	2,029	27,018,684	3,101,847	0.008	0.065

Notes: (1) Totals may not equal the sum of the components due to rounding.
(2) "NA" = Not Applicable.
(3) "ND" = No Data is available.
Sources: CONSAD [5], IRS [15], U.S. Census [43, 44, 45, 46].

As is evident from the data presented in Table 51, the costs of compliance with the present rulemaking are not large in relation to the corresponding annual financial flows associated with the regulated activities. The estimated

costs of compliance represent about 0.008 percent of revenues and 0.065 percent of profits, on average, across all entities; compliance costs do not represent more than about 0.11 percent of revenues or more than about 2.14 percent of profits in any affected industry.

The economic impact of the present rulemaking is most likely to consist of a small increase in prices for electricity of about 0.008 percent, on average. It is unlikely that a price increase of the magnitude of 0.008 percent will significantly alter the services demanded by the public or any other affected customers or intermediaries. If the regulated community can substantially recoup the compliance costs of the present rulemaking with such a minimal increase in prices, there may be little effect on profits.[573]

In general, it is unlikely that most establishments could pass none of the compliance costs along in the form of increased prices. In the event that unusual circumstances may inhibit even a price increase of 0.11 percent, the maximum reduction in profits in any of the affected industries would be about 2.14 percent.

OSHA established a minimum threshold of annualized costs equal to 1 percent of annual revenues and 10 percent of annual profits. OSHA also determined that costs below this minimum threshold will not threaten the economic viability of an affected industry. Table 51 shows that the estimated annualized cost of the final rule is, on average, equal to only 0.008 percent of annual revenue and 0.065 percent of annual profit, far below the minimum threshold. Similarly, there is no individual affected industry in which the annualized costs of the final rule approaches 1 percent of annual revenues or 10 percent of annual profits. The industries with the highest cost impacts, NAICS 234990 (All Other Heavy Construction) and SIC 0783 (Ornamental Shrub and Tree Services), have cost impacts as a percentage of revenues of only about 0.1 percent each and cost impacts as a percentage of profits of only about 2 percent each. Based on these results, there would be no threat to the economic viability of any affected industry even if the costs of the final rule were nine times higher than OSHA estimated, as the highest cost impact as a percentage of revenues in any affected industry would still be less than 1 percent. Furthermore, the costs of the final rule would have to be five times higher than OSHA estimated for the cost impact as a percentage of revenues in any affected industry to approach 10 percent, the point at which further, more detailed, examination is needed to determine if the final rule might threaten the economic viability of any affected industry. For these reasons, the Agency believes that the finding of economic feasibility is robust for this rulemaking. A simple sensitivity analysis of the results finds that even if aggregate costs were several times larger than those estimated here, the rule would still be economically feasible.

In profit-earning entities, establishments generally can absorb compliance costs through a combination of increases in prices and reduction in profits. The extent to which the impacts of cost increases affect prices or profits depends on the price elasticity of demand for the products or services produced and sold by the entity.

Price elasticity of demand refers to the relationship between changes in the price charged for a product and the resulting changes in the demand for that product. A greater degree of elasticity of demand implies that an entity or industry is less able to pass increases in costs through to its customers in the form of a price increase and, therefore, must absorb more of the cost increase through a reduction in profits.

Given the small incremental increases in prices potentially resulting from compliance with the final rule, and the lack of readily available substitutes for the products and services provided by the covered industries, demand is likely to be sufficiently inelastic in each affected industry to enable entities to substantially offset compliance costs through minor price increases without experiencing any significant reduction in total revenues or in net profits.

For the economy as a whole, OSHA expects the economic impact of the present rulemaking to be both an increase in the efficiency of production of goods and services and an improvement in the welfare of society. First, as demonstrated by the analysis of costs and benefits associated with compliance with the requirements of the final rule, OSHA expects that societal welfare will increase as a result of these standards because the benefits achieved clearly and strongly justify the relatively small costs. The impacts of the final rule involve net benefits of over $100 million achieved in a relatively cost-effective manner.

Second, until now, society externalized many of the costs associated with the injuries and fatalities resulting from the risks addressed by the final rule. That is, the costs incurred by society to supply certain products and services associated with electric power generation, transmission, and distribution work did not fully reflect in the prices of those products and services. Workers who suffer the consequences associated with the activities causing these risks partly bore the costs of production. To the extent society externalizes fewer of these costs, the price mechanism will enable the market to result in a more efficient allocation of resources. Note that reductions in externalities alone do not necessarily increase efficiency or social welfare unless the associated benefits outweigh the costs of achieving the reductions.

OSHA concludes that compliance with the requirements of the final rule is economically feasible in every affected industry. The Agency based this conclusion on the criteria established by the OSH Act, as interpreted in relevant case law. In general, the courts hold that a standard is economically feasible if there is a reasonable likelihood that the estimated costs of compliance "will not threaten the existence or competitive structure of an industry, even if it does portend disaster for some marginal firms" (*United Steelworkers of America* v. *Marshall*, 647 F.2d 1189, 1272 (D.C. Cir. 1980)). As demonstrated by this Final Economic Analysis and the supporting evidence, the potential impacts associated with achieving compliance with the final rule fall well within the bounds of economic feasibility in each industry. OSHA does not expect compliance with the requirements of the final rule to threaten the viability of entities or the existence or competitive structure of any of the affected industries. No commenters suggested that the regulation would not be economically feasible.

In addition, based on an analysis of the costs and economic impacts associated with this rulemaking, OSHA concludes that the effects of the final rule on international trade, employment, wages, and economic growth for the United States will be negligible.

[573] One commenter questioned the ability of electric cooperatives to adjust their rates, as they are "highly regulated" (Ex. 0173). The commenter asserted that it could take more than a year to raise rates, if at all.

The Agency does not assume cost pass-through in establishing economic feasibility; the estimate of costs as a percentage of profits represents the possibility that there is no cost pass-through. Moreover, for this rulemaking, the profit impacts would be small. Finally, this economic-impact analysis captures ongoing issues for economic feasibility, not just the first year. If it takes a year or two to raise prices, this is well within the realm of possibilities. Industries may not be able to raise prices immediately for a variety of reasons—for market, as well as regulatory, reasons.

17. Statement of Energy Effects

As required by Executive Order 13211 and in accordance with the guidance for implementing Executive Order 13211 and with the definitions provided therein as prescribed by the Office of Management and Budget, OSHA analyzed the final rule with regard to its potential to have a significant adverse effect on the supply, distribution, or use of energy. As a result of this analysis, OSHA determined that this action is not a significant energy action as defined by the relevant OMB guidance.

H. Final Regulatory Flexibility Analysis

The Regulatory Flexibility Act, as amended in 1996, requires the preparation of a Final Regulatory Flexibility Analysis (FRFA) for certain rules (5 U.S.C. 601–612). Under the provisions of the law, each such analysis must contain:

1. A succinct statement of the need for, and objectives of, the rule;

2. A summary of the significant issues raised by the public comments in response to the initial regulatory flexibility analysis, a summary of the assessment of the agency of such issues, and a statement of any changes made in the final rule as a result of such comments;

3. A description and an estimate of the number of small entities to which the rule will apply or an explanation of why no such estimate is available;

4. A description of the projected reporting, recordkeeping, and other compliance requirements of the rule, including an estimate of the classes of small entities that will be subject to the requirement and the type of professional skills necessary for preparation of the report or record; and

5. A description of the steps the agency took to minimize the significant economic impact on small entities consistent with the stated objectives of applicable statutes, including a statement of the factual, policy, and legal reasons for selecting the alternative adopted in the final rule and why the agency rejected each one of the other significant alternatives to the rule considered by the agency that affect the impact on small entities.

The Regulatory Flexibility Act further states that an agency may perform the required elements of the FRFA in conjunction with, or as part of, any other agenda or analysis required by any other law if such other analysis satisfies the relevant requirements.

1. A Succinct Statement of the Need for, and Objectives of, the Rule

The primary objective of the final rule is to provide an increased degree of occupational safety for employees performing electric power generation, transmission, and distribution work. As stated earlier, the final rule will prevent an estimated 119 injuries and about 20 fatalities annually through compliance with the final rule, in addition to injuries and fatalities prevented through compliance with existing standards.

Another objective of the present rulemaking is to provide updated, clear, and consistent safety standards regarding electric power generation, transmission, and distribution work to relevant employers and employees and interested members of the public. The final rule is easier to understand and to apply than existing standards, which will improve safety by facilitating compliance.

2. A Summary of the Significant Issues Raised by the Public Comments in Response to the Initial Regulatory Flexibility Analysis, a Summary of the Assessment of the Agency of Such Issues, and a Statement of Any Changes Made in the Final Rule as a Result of Such Comments

Few public commenters focused on the specific results of the Initial Regulatory Flexibility Analysis. OSHA responds to the few issues raised by the commenters elsewhere in this FEA.

3. A Description and an Estimate of the Number of Small Entities To Which the Rule Will Apply or an Explanation of Why No Such Estimate Is Available

OSHA completed an analysis of the type and number of small and very small entities to which the final rule will apply. Relying on the Small Business Administration definitions [51], OSHA estimated the number of firms in the construction and Ornamental Shrub and Tree Services (SIC 0783) industries that are small businesses based on revenue and estimated the number of firms in the utilities industries that are small businesses based on sales (in megawatt-hours). With the exception of Major Publically Owned Utilities, the Agency converted definitions based on megawatt-hours to revenue cutoffs using the EIA's Form EIA–860 Database Annual Electric Generator Report, which estimates the average revenue per mega watt-hour to be $99.59 [49]. Multiplying $99.59 by the 4-million megawatt-hour cutoff in the SBA definitions suggests a revenue cutoff for small utilities of $398,363,132. After determining revenue cutoffs implied by the SBA definitions for every affected NAICS, OSHA found the revenue of the largest employment-size class in the U.S. Census' Statistics of U.S. Businesses [43] equal to, or smaller than, the revenue implied in the SBA definition and then designated entities of that size or smaller as "small."

In the case of Major Publicly Owned Utilities, as explained earlier in this FEA, OSHA estimates, based on EIA's Form-861 Annual Electric Power Industry Report, that there are now 277 firms that are major publicly owned utilities [50]. (See the discussion under the heading "Profile of Affected Industries," earlier in this section of the preamble). Of the 277 Major Publicly Owned Utilities in the EIA Form-861 database, 261 have sales of less than 4-million megawatt-hours, and 16 have sales of more than 4-million megawatt-hours. OSHA did not convert this sales data to a revenue or employment-size class equivalent because EIA's Form 861 database does not include employment data and because the U.S. Census' *Statistics of U.S. Businesses* does not include data for Major Publicly Owned Utilities distinct from nonmajor or privately owned utilities. Thus, OSHA used the 4-million megawatt-hour cutoff in the SBA definitions to designate as small the 261 entities with sales of less than 4 million megawatt-hours.

Table 52 summarizes the small business definitions discussed herein.

For small entities, OSHA estimates the total cost of the final rule per small firm to be $3,159. (See Table 53.)

To assess the potential economic impact of the rule on small entities, OSHA calculated the ratios of compliance costs to profits and to revenues. Table 53 presents these ratios for each affected industry. OSHA expects that, among small firms potentially affected by the rule, the average increase in prices necessary to completely offset the compliance costs will be less than 0.138 percent in any individual affected industry and an average of 0.010 percent for all affected industries.

Only to the extent that such price increases are not possible would there be any effect on the average profits of small firms. Even in the unlikely event that these firms could not pass the costs through, the firms could absorb the compliance costs completely through an average reduction in profits of no more than 2.9 percent in any single affected industry and through an average reduction in profits of 0.086 percent in all affected industries.

OSHA also separately examined the impact of the final rule on very small entities, defined as entities with fewer than 20 employees. In the proposed rule, the numbers presented in the CONSAD report for small, large, and total establishments were from the 1997

U.S. Economic Census. For this FEA, OSHA used the U.S. Census Bureau's *2007 Statistics of U.S. Businesses* [43] to update the numbers used in the PRIA. Based on these data, OSHA estimated that the final rule would affect a total of approximately 11,004 very small firms. Table 54 presents the estimated number of affected very small firms in each industry.

OSHA modified the analysis it made in the PRIA to accurately reflect the number of affected very small entities, as well as compliance costs, revenues, and profits per affected entity. In general, OSHA assumed that the profile of the affected firms mirrored the profile of rest of industry. However, in the case of Ornamental Tree and Shrub Services, SIC 0723, the Agency recognized that the limited number of very small entities actually involved in line-clearance tree trimming was atypical for the industry, as very small entities involved in line-clearance tree trimming have significantly more employees than the average firm in this SIC category. Corresponding to their relatively larger employment, very small entities involved in line-clearance tree trimming likely have larger revenue than the average firm in the industry.

OSHA calculated the ratios of compliance costs to profits and to revenues for very small firms. Table 54 presents these ratios for each affected industry. OSHA expects that, among very small firms affected by the final rule, the average increase in prices necessary to completely offset the compliance costs will be 0.040 percent.

Only to the extent that such price increases are not possible would there be any effect on the average profits of small firms. Even in the unlikely event that these firms could not pass the costs through, the firms could absorb the compliance costs completely through an average reduction in profits of less than 0.040 percent.

TABLE 52—SMALL BUSINESS DEFINITIONS

CONSAD/1997 NAICS	CONSAD industry name	2002/2007 NAICS	2002/2007 industry name	SBA size standard ($ million or mega watt-hours, as applicable)	Equivalent revenue ($ million)	Equivalent employment size category (max. employees)
234910	Water, Sewer, and Pipeline Construction.	237110	Water and Sewer Line and Related Structures Construction.	$33.5	NA	100
		237120	Oil and Gas Pipeline and Related Structures Construction.	33.5	NA	100
234920	Power and Communication Transmission Line Construction.	237130	Power and Communication Line and Related Structures Construction.	33.5	NA	All
237120	Industrial Nonbuilding Structure Construction.	236210	Industrial Building Construction.	33.5	NA	100
		237120	Oil and Gas Pipeline and Related Structures Construction.	33.5	NA	100
		237130	Power and Communication Line and Related Structures Construction.	33.5	NA	All
234990	All Other Heavy Construction.	236210	Industrial Building Construction.	33.5	NA	100
		237110	Water and Sewer Line and Related Structures Construction.	33.5	NA	100
		237990	Other Heavy and Civil Engineering Construction.	33.5	NA	500
		238910	Site Preparation Contractors.	14.0	NA	100
		238990	All Other Specialty Trade Contractors.	14.0	NA	100
235310	Electrical Contractors ..	238210	Electrical Contractors.	14.0	NA	100
235910	Structural Steel Erection Contractors.	238120	Structural Steel and Precast Concrete Contractors.	14.0	NA	100
		238190	Other Foundation, Structure, and Building Exterior Contractors.	14.0	NA	100

TABLE 52—SMALL BUSINESS DEFINITIONS—Continued

CONSAD/1997 NAICS	CONSAD industry name	2002/2007 NAICS	2002/2007 industry name	SBA size standard ($ million or mega watt-hours, as applicable)	Equivalent revenue ($ million)	Equivalent employment size category (max. employees)
235950	Building Equipment and Other Machine Installation Contractors.	238290	Other Building Equipment Contractors.	14.0	NA	100
235990	All Other Special Trade Contractors.	236220	Commercial and Institutional Building Construction.	33.5	NA	100
		237990	Other Heavy and Civil Engineering Construction.	33.5	NA	500
		238190	Other Foundation, Structure, and Building Exterior Contractors.	14.0	NA	100
		238290	Other Building Equipment Contractors.	14.0	NA	100
		238390	Other Building Finishing Contractors.	14.0	NA	100
		238910	Site Preparation Contractors.	14.0	NA	100
		238990	All Other Specialty Trade Contractors.	14.0	NA	100
221110	Electric Power Generation.	221111	Hydroelectric Power Generation.	4 million mega watt-hours.	398.4	All
		221112	Fossil Fuel Electric Power Generation.	4 million mega watt-hours.	398.4	500
		221113	Nuclear Electric Power Generation.	4 million mega watt-hours.	398.4	500
		221119	Other Electric Power Generation.	4 million mega watt-hours.	398.4	All
221120	Electric Power Transmission, Control, and Distribution.	221121	Electric Bulk Power Transmission and Control.	4 million mega watt-hours.	398.4	All
		221122	Electric Power Distribution.	4 million mega watt-hours.	398.4	500
2211	Major Publicly Owned Utilities.	2211	Major Publicly Owned Utilities.	4 million mega watt-hours.	NA	NA
SIC 0783	Ornamental Shrub and Tree Services.	561730	Landscaping Services.	7.0	NA	100

Note: "NA" = Not Applicable.
Sources: EIA [49, 50], SBA [51], U.S. Census [43, 44, 45, 46].

TABLE 53—COSTS AS A PERCENT OF REVENUES AND PROFITS FOR AFFECTED SMALL ENTITIES (AS DEFINED BY SBA)

Industry code	Industry name	Affected small firms	Compliance costs per firm	Revenues per firm	Profits per firm	Costs as a percent of revenues	Costs as a percent of profits
NAICS 234910	Water, Sewer, and Pipeline Construction.	968	$465	$8,846,770	$461,801	0.005	0.101
NAICS 234920	Power and Communication Transmission Line Construction.	3,347	3,147	6,736,654	351,653	0.047	0.895
NAICS 234930	Industrial Nonbuilding Structure Construction.	304	1,574	9,022,755	454,446	0.017	0.346
NAICS 234990	All Other Heavy Construction	768	3,605	3,466,142	167,969	0.104	2.146
NAICS 235310	Electrical Contractors	1,903	4,474	6,236,853	269,432	0.072	1.660
NAICS 235910	Structural Steel Erection Contractors	760	176	2,310,169	102,109	0.008	0.172
NAICS 235950	Building Equipment and Other Machine Installation Contractors.	921	138	3,896,757	172,237	0.004	0.080
NAICS 235990	All Other Special Trade Contractors	3,063	127	3,046,117	140,426	0.004	0.090
NAICS 221110	Electric Power Generation	530	9,477	283,932,698	53,720,066	0.003	0.018
NAICS 221120	Electric Power Transmission, Control, and Distribution.	1,134	11,320	162,314,688	15,354,970	0.007	0.074
NAICS 2211	Major Publicly Owned Utilities	261	6,177	162,113,144	NA	0.004	NA
Various	Industrial Power Generators	0	NA	NA	NA	NA	NA
SIC 0783	Ornamental Shrub and Tree Services	303	7,231	5,259,210	225,620	0.138	3.205
Total		14,263	3,159	30,956,353	3,437,179	0.010	0.092

Notes: (1) Totals may not equal the sum of the components due to rounding.
(2) "NA" = Not Applicable.

Sources: CONSAD [5], EIA [49, 50], IRS [15], SBA [51], U.S. Census [43, 44, 45, 46].

TABLE 54—COSTS AS A PERCENT OF REVENUES AND PROFITS FOR AFFECTED VERY SMALL ENTITIES (THOSE WITH FEWER THAN 20 EMPLOYEES)

Industry code	Industry name	Affected firms with fewer than 20 employees	Compliance costs per firm	Revenues per Firm	Profits per Firm	Costs as a percent of 'revenues	Costs as a percent of profits
NAICS 234910	Water, Sewer, and Pipeline Construction.	759	$220	$1,088,731	$56,832	0.020	0.388
NAICS 234920	Power and Communication Transmission Line Construction.	2,651	1,187	913,129	47,665	0.130	2.490
NAICS 234930	Industrial Nonbuilding Structure Construction.	142	100	1,164,177	58,636	0.009	0.171
NAICS 234990	All Other Heavy Construction	689	1,895	958,076	46,428	0.198	4.082
NAICS 235310	Electrical Contractors	1,731	2,597	2,223,705	96,064	0.117	2.704
NAICS 235910	Structural Steel Erection Contractors	608	96	734,692	32,473	0.013	0.296
NAICS 235950	Building Equipment and Other Machine Installation Contractors.	748	77	832,404	36,792	0.009	0.209
NAICS 235990	All Other Special Trade Contractors	2,916	96	836,651	38,570	0.011	0.248
NAICS 221110	Electric Power Generation	316	2,841	29,775,772	5,633,576	0.010	0.050
NAICS 221120	Electric Power Transmission, Control, and Distribution.	322	6,415	33,598,972	3,178,463	0.019	0.202
NAICS 2211	Major Publicly Owned Utilities	33	5,868	4,740,998	NA	0.124	NA
Various	Industrial Power Generators	0	NA	NA	NA	NA	NA
SIC 0783	Ornamental Shrub and Tree Services ...	90	2,047	849,923	36,462	0.241	5.614
Total	.....	11,004	1,169	2,898,088	303,777	0.040	0.385

Notes: (1) Totals may not equal the sum of the components due to rounding.
(2) "NA" = Not Applicable.
Sources: CONSAD [5], IRS [15], U.S. Census [43, 44, 45, 46].

4. A Description of the Projected Reporting, Recordkeeping and Other Compliance Requirements of the Rule, Including an Estimate of the Classes of Small Entities That Will Be Subject to the Requirement and the Type of Professional Skills Necessary for Preparation of the Report or Record

OSHA is revising the standards addressing the work practices employers will use, and other requirements they will follow, for the operation and maintenance of, and for construction work involving, electric power generation, transmission, and distribution installations. OSHA issued the existing rules for this type of work in 1972 for construction work and in 1994 for work covered by general industry standards. The construction standards, in particular, are out of date and are not consistent with the more recent, corresponding general industry rules for the operation and maintenance of electric power generation, transmission, and distribution systems. As described in detail earlier, this final rule will make the construction and general industry standards for this type of work more consistent than is currently the case.

Existing § 1910.269 contains requirements for the maintenance and operation of electric power generation, transmission, and distribution installations. Section 1910.269 is primarily a work-practices standard. OSHA based the requirements in § 1910.269 on recognized safe industry practices as reflected in current national consensus standards covering this type of work, such as the National Electrical Safety Code.

Section 1910.269 contains provisions protecting employees from the most serious hazards they face in performing this type of work, primarily hazards causing falls, burns, and electric shocks. Requirements in § 1910.269 include provisions on training, job briefings, working near energized parts, deenergizing lines and equipment and grounding them for employee protection, work on underground and overhead installations, work in power-generating stations and substations, work in enclosed spaces, and other special conditions and equipment unique to the generation, transmission, and distribution of electric energy.

OSHA also is extending its general industry standard on electrical protective equipment (§ 1910.137) to the construction industry. The existing construction standards for the design of electrical protective equipment, which apply only to electric power transmission and distribution work, adopted several national consensus standards by reference. This final rule replaces the incorporation of these out-of-date consensus standards with a set of performance-oriented requirements that are consistent with the latest revisions of these consensus standards and with the corresponding standard for general industry. Additionally, OSHA is issuing new requirements for the safe use and care of electrical protective equipment to complement the equipment-design provisions. The final rule, which will apply to all construction work, will update the existing OSHA industry-specific standards and will prevent accidents caused by inadequate electrical protective equipment.

As discussed in detail earlier, OSHA does not expect this transfer to the construction standards of the existing general industry standards in § 1910.137 and § 1910.269 to impose a significant burden on employers. Generally, many employers doing construction work also do general industry work; thus, OSHA believes that they are already following the existing general industry standards in their construction work. The final provisions in Subpart V also are generally consistent with the latest national consensus standards.

In addition, OSHA also is making miscellaneous changes to the existing requirements in § 1910.137 and § 1910.269. These changes include requirements for: Class 00 rubber insulating gloves; electrical protective equipment made from materials other than rubber; training for electric power generation, transmission, and distribution workers; host-contractor responsibilities; job briefings; fall protection equipment; insulation and working position of employees working on or near live parts; protective clothing; minimum approach distances; deenergizing transmission and

distribution lines and equipment; protective grounding; operating mechanical equipment near overhead power lines; and working in manholes and vaults.

These changes to the general industry standards, because they also apply to construction, will ensure that consistent requirements, when appropriate, apply to employers engaged in work performed under the construction and general industry standards. As explained more fully in Section V, Summary and Explanation of the Final Rule, earlier in this preamble, OSHA believes that this consistency will further protect employees performing electrical work covered under the general industry standards. The rule also updates references to consensus standards in §§ 1910.137 and 1910.269 and adds a new appendix to assist employers to comply with the new clothing provisions.

Section V, Summary and Explanation of the Final Rule, earlier in this preamble, provides further detail regarding the requirements of the final rule.

The preceding sections of this economic analysis present a description of the classes of small entities that are subject to the final rule, as well as the types of professional skills necessary to comply with the requirements.

5. A Description of the Steps the Agency Took To Minimize the Significant Economic Impact on Small Entities Consistent With the Stated Objectives of Applicable Statutes, Including a Statement of the Factual, Policy, and Legal Reasons for Selecting the Alternative Adopted in the Final Rule, and Why the Agency Rejected Each One of the Other Significant Alternatives to the Rule Considered by the Agency That Affect the Impact on Small Entities

OSHA evaluated many alternatives to the final rule to ensure that the final requirements will best accomplish the stated objectives of applicable statutes and minimize any significant economic impact of the rule on small entities.

In developing the rule, and especially in establishing compliance, reporting requirements, or timetables that affect small entities, OSHA took the resources available to small entities into account. To the extent practicable, OSHA clarified, consolidated, and simplified compliance and reporting requirements under the rule that are applicable to small entities. Wherever possible, OSHA stated the final rule's requirements in terms of performance rather than design specifications. OSHA did not consider an exemption from coverage of the rule for small entities to be a viable option because such an exemption would unduly jeopardize the safety and health of the affected employees.

OSHA considered many other specific alternatives to the present requirements. Section V, Summary and Explanation of the Final Rule, earlier in this preamble, provides a discussion and explanation of the particular requirements of the rule and the alternatives OSHA considered.

OSHA considered other regulatory alternatives raised by the Small Business Advocacy Review Panel, which OSHA convened for purposes of soliciting comments on the rule from affected small entities. The Agency discusses these alternatives later in this economic analysis.

OSHA also considered nonregulatory alternatives in determining the appropriate approach to reducing occupational hazards associated with electric power generation, transmission, and distribution work. The Agency discusses these alternatives under the heading "Examination of Alternative Regulatory Approaches," earlier in this section of the preamble.

Alternatives Considered and Changes Made in Response to Comments From SERs and Recommendations From the Small Business Advocacy Review Panel

On May 1, 2003, OSHA convened a Small Business Advocacy Review Panel (SBAR Panel or Panel) for this rulemaking in accordance with the provisions of the Small Business Regulatory Enforcement Fairness Act of 1996 (Pub. L. 104–121), as codified at 5 U.S.C. 601 *et seq.* The SBAR Panel consisted of representatives from OSHA, the Office of Information and Regulatory Affairs (OIRA) in the Office of Management and Budget, and the Office of Advocacy within the U.S. Small Business Administration. The Panel received, from small entities potentially affected by this rulemaking, oral and written comments on a draft rule and on a draft economic analysis. The Panel, in turn, prepared a written report, which it delivered to the Assistant Secretary for Occupational Safety and Health [29]. The report summarized the comments received from the small entities and included recommendations from the Panel to OSHA regarding the rule and the associated analysis of compliance costs.

Table 55 lists each of the recommendations made by the Panel and describes the corresponding answers or changes made by OSHA in response to the issues raised.

TABLE 55—PANEL RECOMMENDATIONS AND OSHA RESPONSES

Panel recommendations *	OSHA Responses
1. The SERs generally [believed] that OSHA had underestimated the costs and may have overestimated the benefits in [the draft] economic analysis [provided to the SERs]. The Panel recommends that OSHA revise its economic and regulatory flexibility analysis as appropriate, and that OSHA specifically discuss the alternative estimates and assumptions provided by SERs and compare them to OSHA's revised estimates.	OSHA revised its economic and regulatory flexibility analysis as appropriate in light of the additional information received from the SERs and rulemaking participants. Many of the comments from the SERs asserting deficiencies in the estimates of the compliance costs were the result of differing interpretations of what would have to be done to achieve compliance with particular requirements. Some SERs remarked that OSHA underestimated the time and resources that would be necessary to develop and maintain written records associated with requirements for making determinations regarding training and protective clothing, for documenting employee training, and for communicating with host employers or contractors about hazards and appropriate safety practices. OSHA clarified, in some cases in the preamble and other cases in the regulatory text, that the final rule does not require written records to achieve compliance with these provisions of the final rule.

TABLE 55—PANEL RECOMMENDATIONS AND OSHA RESPONSES—Continued

Panel recommendations*	OSHA Responses
	In some cases, the SERs also interpreted the draft requirements associated with job briefings, host-contractor responsibilities, and incident-energy calculations in ways that would involve higher compliance costs than those estimated by OSHA, but that were not consistent with the way in which OSHA intended employers to achieve compliance. In these cases, OSHA clarified, in the preamble and regulatory text, what would be necessary to comply with the standards to alleviate the corresponding potential cost and impact concerns raised by the SERs. With regard to the cost for training that will be necessary for employees currently not requiring training in accordance with the existing training requirements in §1910.269, OSHA revised its compliance cost calculations to account for one-time and annual cost of the additional training these employees will receive, as described under the headings "One-Time Costs for Additional Training for Employees Not Already Receiving Training in Accordance with Existing §1910.269" and "Annual Costs for Additional Training for Employees Not Already Covered by §1910.269," earlier in this section of the preamble. For employees currently provided the training required by existing §1910.269, OSHA generally included costs equivalent to 1.5 hours of employee time, 12 minutes of supervisory time, and 3 minutes of clerical time per employee. In the case of line-clearance tree trimmers, OSHA assumed 0.75 hours of employee time, 6 minutes of supervisory time, and 3 minutes of clerical time per employee. Most SERs indicated that the job briefing requirements were generally consistent with current practices and that 5 minutes for the additional job briefing requirements per project would be a reasonable estimate for the amount of time involved. For purposes of estimating compliance costs in this analysis, OSHA used estimates of current compliance of 85 percent to 98 percent, and estimated that each affected project would require resources equivalent to 5 minutes of supervisor time and 5 minutes of employee time. With regard to the cost associated with providing flame-resistant clothing to employees, the SERs generally suggested that OSHA's estimate of two sets per employee per year for small establishments and five sets per employee every 5 years for large establishments was an underestimate. The SERs also gave OSHA broad estimates of the costs of flame-resistant clothing, ranging from $50 per shirt to $150 for switching coats or flash suits. Several SERs agreed that many companies contract with uniform companies to supply and launder clothing. In the FEA, in the analysis of compliance costs associated with the requirements to provide flame-resistant clothing, OSHA estimates that, on average, employers will provide eight sets of clothing per employee, and that, with eight sets per employee, the useful life of the clothing will average 4 years. OSHA estimated the cost per set of clothing to be $110 in the analysis of the proposed rule, but increased that estimate to $192 in this analysis to reflect current costs [13]. This analysis excluded laundering costs because the rule does not require employers to launder the clothing. OSHA estimated the cost per switching coat or flash suit to be $200 in the analysis of the proposed rule and increased that estimate to $226 in this analysis to reflect current costs [19].
2. In [the draft] economic and RFA analyses [provided to the SERs], OSHA assumed that all affected firms apply existing [§]1910.269 to construction related activities, even though not required to do so. The reason OSHA made this assumption is [that] OSHA thought that all affected firms are either covered solely by [Part] 1910, or engage in both [Part] 1910 and [Part] 1926 activities, and find it easiest to adopt the general industry standard for all activities. SERs confirmed that most firms do in fact follow [§]1910.269. However, they also pointed out that there are some firms that are engaged solely in construction activities and thus may not be following the [Part] 1910 standards. The Panel recommends that OSHA revise its economic and regulatory flexibility analyses to reflect the costs associated with some firms coming into compliance with [§]1910.269. The SERs also reported that compliance training under [§]1910.269 is extensive. One SER estimated that in excess of 30 hours per employee is necessary in the first year. The Panel recommends that OSHA consider the SER comments on training and revise its estimate of training costs as necessary.	OSHA's final economic and regulatory flexibility analyses reflect additional costs for firms previously not required to comply with §1910.269. Specifically, OSHA estimated that these firms would incur compliance costs equivalent to the costs incurred by firms affected by the new requirements of §1910.269 when OSHA promulgated it originally in 1994. In addition, OSHA considered the SER comments on training and revised its estimate of training costs accordingly. OSHA added a separate training cost for firms not currently covered by the existing training requirements in §1910.269, as described under the heading "Costs of Compliance," earlier in this section of the preamble.

TABLE 55—PANEL RECOMMENDATIONS AND OSHA RESPONSES—Continued

Panel recommendations*	OSHA Responses
3. Most SERs were concerned that a "performance standard" such as [the draft proposal provided to SERs] means that even in cases where OSHA does not require recordkeeping, such as for training, many small entities will find recordkeeping (1) useful for internal purposes and (2) virtually the only way they will be able to demonstrate compliance with the rule. The Panel recommends that OSHA consider whether recordkeeping is necessary to demonstrate compliance with the standard, and, if not, that OSHA explicitly discuss ways in which employers can demonstrate compliance without using recordkeeping.	The final rule does not require employers to maintain records of training. Employees themselves can attest to the training they receive, and OSHA will determine compliance with the training requirements primarily through employee interviews
4. SERs pointed out that the [draft proposed host-contractor] requirements for observation and follow-up would result in paperwork and reporting requirements not presented in the cost analysis. The Panel recommends that OSHA include such costs and paperwork burdens in its economic analysis as appropriate.	The final rule does not require host employers to supervise contractors' employees or change their practices for observing or inspecting the work of contractors. OSHA has eliminated the draft proposed requirement for the host employer "to note any failures of the contract employer to correct such violations, take appropriate measures to correct the violations, and consider the contract employer's failure to correct violations in evaluating the contract employer." Thus, OSHA did not include costs for the host employer to follow up to ensure that the contract employer corrected any violations. OSHA included estimates of the costs of information collection requirements, and of the associated paperwork burdens, in the paperwork analysis for the final rule.
5. Several SERs argued that [the draft proposal's requirement for] consideration of safety records would restrict the number of eligible contractors, resulting in both increased costs and potential impacts on small firms. Several SERs also were concerned that the draft requirement would result in the increased use of methods such as prequalification in the hiring of contractors or would increase reliance on favored contractors; the SERs said that both of these effects could result in increased costs and restricted business opportunities, especially for small businesses. The Panel recommends that OSHA study the extent of such costs and impacts and solicit comment on them.	The final rule does not contain a requirement for the host employer to obtain and evaluate information on contractors' safety performance and programs. Consequently, the final regulatory flexibility analysis does not include costs associated with this draft proposed provision.
6. Several SERs questioned OSHA's estimates of the number of sets of flame-resistant clothing an employee would need, and its assumptions and cost estimates. The Panel recommends that OSHA reexamine its assumptions and cost estimates in light of these comments.	In the development of the FEA, OSHA reexamined its assumptions and cost estimates with regard to the entire final rule, including the requirements to provide flame-resistant clothing. OSHA's response to Panel recommendation 1, earlier in this table, describes the comments from the SERs and OSHA's revised estimates made in response to these comments.
7. Many SERs questioned whether the * * * revisions to [§]1910.269 would in fact save any lives or prevent any accidents. Some commented that they had never seen an accident that would have been prevented by any of the new provisions [in the draft proposal]. Some SERs suggested that [the draft] analysis [provided to SERs] might have included fatalities in municipal facilities that may not be covered by the standard. Others suggested OSHA should discuss the extent to which the existing general industry standard had resulted in reduced fatalities and injuries, and how this compares with OSHA estimates of how many fatalities and injuries would be prevented by the proposal. The Panel recommends that OSHA provide more documentation regarding the sources and nature of the anticipated benefits attributed to the draft proposal. The [Panel also recommends that the] estimated benefits [in the draft analysis] * * * be reexamined in light of the SER comments and experiences regarding the perceived effectiveness of the new provisions. In particular, [the Panel recommends that] OSHA * * * focus attention on the benefits associated with the provisions on flame-resistant] apparel, training, host/contractor responsibilities, and fall protection.	OSHA collected and compiled information from a variety of sources to document and support the need for the provisions of the final rule. OSHA analyzed the data on the fatalities and injuries that occurred among the affected workforce over the past decade specifically with regard to the effectiveness of both the existing and final requirements in preventing such incidents. The discussion under the heading "Benefits, Net Benefits, and Cost Effectiveness," earlier in this section of the preamble, summarizes this evaluation; the corresponding research report [5] provides a detailed explanation of this evaluation. To quantitatively determine the effectiveness of the existing and final rules in preventing injuries and fatalities, OSHA performed a detailed review of the descriptions of accidents. For each accident reviewed, OSHA analyzed the detailed description of the accident, along with the citations issued, the type of injuries incurred, and the causes associated with the accident to estimate the likelihood that the accident was preventable under, first, the existing applicable standards, and second, the final rule. Based on these analyses, CONSAD found that full compliance with the existing standards would prevent 52.9 percent of the injuries and fatalities; compliance with the final rule, however, would prevent 79.8 percent of the relevant injuries and fatalities. Compared to the existing standards, the final standard increases safety by preventing an additional 20 fatalities and 119 injuries annually. In addition, the final rule improves safety by clarifying and updating the existing standards to reflect modern technologies, work practices, and terminology and by making the standards consistent with current consensus standards and other related standards and documents. By facilitating the understanding of, and compliance with, these important safety standards, the final rule increases protection of employees while reducing uncertainty, confusion, and compliance burdens on employers.

TABLE 55—PANEL RECOMMENDATIONS AND OSHA RESPONSES—Continued

Panel recommendations *	OSHA Responses
	Section V, Summary and Explanation of the Final Rule, earlier in this preamble, includes explanations of the need for, and the expected benefits associated with, specific provisions of the final rule. In particular, see the summary and explanation of final §§ 1926.950(c) (host-contractor responsibilities), 1926.954(b) (fall protection), and 1926.960(g) (flame-resistant clothing) for a discussion of the need for, and a qualitative explanation of, the benefits of these provisions.
8. There were no comments from the SERs on OSHA's estimates [in the draft analysis provided to the SERs] of the number and type of small entities affected by the proposal. However, some [SERs] pointed out that there may be some small entities that engage in only construction related activities. The Panel recommends that OSHA's estimates of current baseline activities and OSHA's cost estimates reflect such firms.	As discussed under the heading "Costs of Compliance," earlier in this section of the preamble, OSHA's FEA, including its estimates of baseline activities and its cost estimates, reflect the possible existence of some firms not currently covered by existing § 1910.269 and that do not comply with these provisions when performing construction work on electric power generation, transmission, or distribution installations.
9. Most SERs were uncertain about how to comply with performance oriented provisions of the proposal, and further, that additional expenses might be required to be confident that they were in compliance with such provisions. The Panel recommends that OSHA study and address these issues and consider the use of guidance material (e.g. non-mandatory appendices) to describe specific ways of meeting the standard, which will help small employers comply, without making the standard more prescriptive.	OSHA included appendices containing guidelines on the inspection of work-positioning equipment to assist employers in complying with the requirement to conduct such inspections described in §§ 1910.269(g)(2)(iv)(A) and 1926.954(b)(3)(i). The final rule also includes appendices on clothing in § 1910.269 and Subpart V of Part 1926. These appendices should assist employers to comply with the clothing provisions in §§ 1910.269(l)(8) and 1926.960(g). The rule also includes many references to consensus standards that contain information that can assist employers to comply with various provisions of the final rule. For example, the note to § 1926.957(b) directs employers to the Institute of Electrical and Electronics Engineers' *IEEE Guide for Maintenance Methods on Energized Power Lines,* IEEE Std 516–2009 for guidance on the examination, cleaning, repairing, and in-service testing of live-line tools to help employers comply with that provision in the OSHA standards. Lastly, Appendix G to § 1910.269 and Appendix G to Subpart V of Part 1926 contain lists of reference documents that employers can access for help in complying with the final rule. The preamble and this analysis both contain additional descriptions of what OSHA considers necessary and sufficient for purposes of achieving compliance with the requirements of the final rule.
10. Most SERs were highly critical of the host contractor provisions [in the draft proposal provided to the SERs] and had trouble understanding what OSHA required. If these provisions are to be retained, the Panel recommends that they be revised. The Panel recommends that OSHA clarify what constitutes adequate consideration of contractor safety performance, clarify what is meant by "observation," clarify how the multi-employer citation policy is related to the proposal, and clarify whether the requirement to communicate hazards does or does not represent a requirement for the host employer to conduct their own risk assessment. The Panel also recommends that OSHA examine the extent to which state contractor licensing could make the host contractor provisions in the proposal unnecessary.	OSHA modified the provisions on host-contractor responsibilities substantially from the requirements in the draft proposal reviewed by the SERs. The Agency believes that the changes address the concerns expressed by the SERs. The final rule does not contain requirements for the host employer to consider a contract employer's safety performance or for the host employer to observe or supervise contract employers' work. In addition, the final rule does not include the proposed requirement that host employers report observed contract-employer-related violations to the contract employer. The discussion of final § 1926.950(c), in Section V, Summary and Explanation of the Final Rule, earlier in this preamble, provides clarification of the purpose and application of the host-contractor requirements and their relationship to OSHA's multiemployer citation policy. The discussion of final § 1926.950(c)(1), in Section V, Summary and Explanation of the Final Rule, earlier in this preamble, makes it clear that the purpose of the requirements for host employers to provide information to contractors is to facilitate the contractors' efforts to perform their own assessments as required by the final rule. OSHA does not believe that State contractor-licensing requirements make the final host-contractor provisions unnecessary. Not all States require electric power generation, transmission, and distribution contractors to have a license. For example, Illinois and New York do not require licensing at the State level (see *http://www.electric-find.com/license.htm*). Additionally, States with such licensing requirements judge primarily the contractors' ability to install electric equipment in accordance with State or national installation codes, and not their ability to perform electric power generation, transmission, and distribution work safely.
11. Some SERs questioned the need for flame-resistant clothing beyond the existing clothing provisions in [§]1910.269. Some argued that there was a trade-off between possible decreased injuries from burns and heat stress injuries as a result of using flame-resistant clothing. The Panel recommends that OSHA consider and solicit comments on these issues.	OSHA considered these issues in the development of the final clothing requirements, as explained in the discussion of final § 1926.960(g), in Section V, Summary and Explanation of the Final Rule, earlier in this preamble.

TABLE 55—PANEL RECOMMENDATIONS AND OSHA RESPONSES—Continued

Panel recommendations*	OSHA Responses
12. Many SERs were uncertain whether [the draft proposal's] requirements for determining the need for flame-resistant clothing would allow the use of such methods as 1) "worst case" analysis or 2) specifying minimum levels of protection for use when a system does not exceed certain limits. The Panel recommends that OSHA clarify what methods are acceptable to meet these requirements, and specify these methods in such a way that small entities can be confident that they have met the requirements of the standards.	OSHA adopted requirements in the final rule that provide guidance explaining ways an employer can comply with the arc-flash protection requirements in §§ 1910.269(l)(8) and 1926.960(g). For example, the Agency included two notes and additional appendix material explaining how an employer can calculate estimates of available heat energy. For additional information, see the discussion of final § 1926.960(g) in Section V, Summary and Explanation of the Final Rule, earlier in this preamble.
13. OSHA['s draft proposal included] some changes to the training provisions in [§]1910.269, including dropping certification requirements and allowing training to vary with risk. OSHA stated that both of these changes were designed to give the rules a greater performance orientation and to ease compliance. Some SERs felt that these changes might make compliance more complicated by making it less clear what needs to be done. The Panel recommends that OSHA clarify the performance orientation of these [draft proposed] changes and consider explaining that existing compliance methods would still be considered adequate under the new rules. The Panel further recommends that OSHA examine the requirement [in existing § 1910.269(a)(2)(vii)] that employees demonstrate proficiency and provide examples of how that can be accomplished. The Panel also recommends that OSHA consider the possibility that the proposed draft may introduce costs to small businesses that are uncertain of how to comply with the new performance oriented training provisions.	OSHA believes that the changes this final rule makes to the training requirements in existing § 1910.269 clarify the standard and reduce burdens on employers. See the discussion of final § 1926.950(b), in Section V, Summary and Explanation of the Final Rule, earlier in this preamble, for additional clarification on how to comply with the training requirements in the final rule. OSHA did not state that compliance with the training provisions in existing § 1910.269 will constitute compliance with the training provisions in the final rule because employers will need to develop and provide additional training to address the new and revised safety-related work-practice requirements in the final rule. Thus, training that complies with existing § 1910.269 will not be sufficient under the final rule. Existing § 1910.269(a)(2)(vii) already requires employees to demonstrate proficiency in the work practices involved. OSHA believes that most employers are already complying with this requirement in various ways. For example, some employers have employees demonstrate proficiency in climbing after completing a pole-climbing class that includes climbing on practice poles as part of the curriculum. In addition, many employers use an apprenticeship program, in which journeyman line workers acting as crew leaders observe trainees over the course of the program. The trainees pass through the apprenticeship program by successfully completing each step, demonstrating proficiency in various tasks along the way, until the trainees reach the journeyman level. In addition to the guidance provided in the preamble and appendices on how to comply with the new training requirements, the Agency is planning to issue a Small Entity Compliance Guide covering these issues following publication of the standard.
14. Several SERS argued that the [draft] proposal placed restrictions on the length of [a] lanyard and that these restrictions were unworkable. The Panel recommends that OSHA clarify the intent of the fall protection provisions. Other SERs argued that fall fatalities from aerial lifts were either the result of catastrophic failures in which case fall protection would not have prevented the death, or the result of failure to use any form of fall arrest or fall restraint. Some SERs argued that some workers might find harnesses more awkward than belts and be less likely to wear them. The Panel recommends that OSHA consider and solicit comment on these issues.	OSHA clarified the purpose of the changes to the fall protection requirements in final § 1926.954(b)(1)(i) and (b)(2) in the discussion of those provisions in Section V, Summary and Explanation of the Final Rule, earlier in this preamble. The Agency also clarified the requirements in final § 1926.954(b)(3)(iii) to use fall protection equipment to make it clear what each type of fall protection system is and when it is acceptable. The discussion of final § 1926.954(b)(3)(iii), in Section V, Summary and Explanation of the Final Rule, earlier in this preamble, describes why the reasons provided by the SERs did not persuade the Agency to permit the use of body belts in a fall arrest system.
15. This rule was designed by OSHA to eliminate confusing differences between the applicable construction and general industry standards by making the standards consistent. Several SERs felt this was a worthwhile goal. Some SERs felt that the host contractor provisions of the rule could result in causing contractor employees to be considered employees of the host employer under the Fair Labor Standards Act and under the Internal Revenue Service regulations. In addition, the SERs identified OSHA's multi-employer citation policy as duplicative and overlapping of the host contractor provisions in the proposal. The Panel recommends that, if this provision is retained, OSHA investigate this issue and clarify these provisions to assure that contractor employees do not become direct employees of the host employer as a result of complying with possible OSHA requirements.	OSHA does not believe that the provisions on host-contractor responsibilities duplicate or overlap the Agency's multiemployer policy or create employer-employee relationships for FLSA or IRS purposes. See the discussion of final § 1926.950(c) in Section V, Summary and Explanation of the Final Rule, earlier in this preamble, for a full discussion of these issues.
16. Some SERs were unconvinced about the need for revisions to the existing [§]1910.269 standard in light of their potential to improve safety beyond what compliance with the requirements in existing [§]1910.269 would achieve. The Panel recommends that OSHA consider and solicit comment on the regulatory alternative of extending the requirements of [§]1910.269 to construction, without further modification.	The Agency received no comments on the regulatory alternative of extending existing § 1910.269, in its entirety, to construction without further modification. In any event, the Agency finds that the additional changes to both § 1910.269 and Subpart V will prevent a significant number of fatalities and injuries each year.

TABLE 55—PANEL RECOMMENDATIONS AND OSHA RESPONSES—Continued

Panel recommendations *	OSHA Responses
17. The Panel notes that [the draft proposed host-contractor] provisions were particularly troublesome for almost all SERs, and that as a result, OSHA should provide either some change or provide extensive clarification to these [draft proposed] provisions. The Panel recommends that OSHA consider, analyze, and solicit comment on a variety of alternatives to these [draft proposed] provisions, including: (1) Dropping all or some of these provisions. (2) Specifying in detail methods that would be considered adequate for purposes of compliance for those provisions retained. (3) Changing the provision for consideration of safety performance to indicate how employers can be sure they have complied with the provision. (4) Changing the provisions concerning observed violations by: • Dropping the provision concerning observed violations entirely; • Changing the provision concerning observed violations to clearly indicate that "inspections" are not required; • Minimizing the amount of follow-up and responsibility placed on the host employer when a violation is observed; • Requiring only that the contractor be notified of observed violations (no requirement for subsequent monitoring or evaluation); • Changing the provision to require observation for the purpose of determining if the contractor is performing safe work practices, and requiring observed violations to be reported to the contractor (no requirement for subsequent monitoring or evaluation); • Providing explicit language that line clearance tree trimmers are not covered by this provision; • Specifying that only observations made by a "safety professional" or other individual qualified to identify hazards must be reported to the contractor. (5) Changing the provision for hazard communication to make clear that the host employer is not required to conduct his or her own hazard analysis, but only to communicate such hazards of which the host employer may be aware.	OSHA considered these options and adopted several of them. See the discussion of final § 1926.950(c) in Section V, Summary and Explanation of the Final Rule, earlier in this preamble, for additional discussion of these provisions.
18. The Panel recommends that OSHA consider and solicit comment on two kinds of options with respect to flame-resistant clothing. First, [the Panel recommends that] OSHA consider the alternative of no further requirements beyond existing [§]1910.269 for the use of flame-resistant clothing. Second, [the Panel recommends that,] should the draft requirement be retained in some manner, OSHA * * * consider and solicit comment on one or a combination of alternative means of determining how much protection is needed or required. These alternatives should include: (1) Allowing the employer to estimate the exposure assuming that the distance from the employee to the electric arc is equal to the minimum approach distance. (2) Providing tables showing heat energy for different exposure conditions as an alternative assessment method. (3) Specifying a minimum level of protection for overhead line work (for example, 10 cal/cm2) for use when the system does not exceed certain limits as an alternative to hazard assessment. (4) Allowing the employer to reduce protection when other factors interfere with the safe performance of the work (for example, severe heat stress) after the employer has considered alternative methods of performing the work, including the use of live-line tools and deenergizing the lines and equipment, and has found them to be unacceptable. (5) Allowing employers to base their assessments on a "worst case analysis." (6) Requiring employers to use appropriate flame-retard[a]nt clothing without specifying any assessment method.	OSHA considered the options recommended by the Panel. The Agency adopted the second option suggested by the Panel. Appendix E to § 1910.269 and Appendix E to Part 1926, Subpart V, contain tables that employers may use to estimate available heat energy. Although these tables do not cover every circumstance, they do address many exposure conditions found in overhead electric power transmission and distribution work. Other assessment aids are available, and also listed in the two appendices, for other exposure conditions, including typical electric power generation exposures. OSHA did not incorporate any of the other Panel-recommended options into the final rule because the Agency either currently believes that they are not sufficiently protective or has insufficient information to incorporate them. See the discussion of final § 1926.960(g), in Section V, Summary and Explanation of the Final Rule, earlier in this preamble, for a discussion of the regulatory alternatives recommended by rulemaking participants and considered by the Agency.

TABLE 55—PANEL RECOMMENDATIONS AND OSHA RESPONSES—Continued

Panel recommendations*	OSHA Responses
19. Some SERs were concerned that the revised training requirements [contained in the draft proposal] complicated the question of demonstrating that training had been provided, and that the [draft proposed] requirement that training be related to the risk would require additional training, additional documentation, or both. The Panel recommends that OSHA consider making it clear that employers that follow the existing training provisions in [§]1910.269 will be in compliance with the new rules, and that OSHA clarify alternative methods that would be considered acceptable for demonstrating adequacy of training and the relation of the training to risk.	See OSHA's response to Panel recommendation 13, earlier in this table, and the discussion of final § 1926.950(b), in Section V, Summary and Explanation of the Final Rule, earlier in this preamble.
20. In response to comment by some SERs, the Panel recommends that OSHA consider and solicit comment on the issue of whether the additional job briefing requirements [in the draft proposal] are needed and how they can be met in situations in which the employee is working at a distant location.	OSHA is adopting only one new requirement related to job briefings. Final §§ 1910.269(c)(1)(i) and 1926.952(a)(1) require the employer to provide the employee in charge of the job with all available information that relates to the determination of existing characteristics and conditions that the crew must complete. For additional discussion of this provision and related comments, see the discussion of final § 1926.952(a)(1) in Section V, Summary and Explanation of the Final Rule, earlier in this preamble. The Agency believes that many employers are already providing relevant information about a job when they assign that job to a crew of employees or to an employee working alone. OSHA anticipates that employers will pass along the required information when they assign jobs to employees. Where the employees are working has no effect on the employer's ability to communicate the information.
21. All of the affected SERs felt that the provisions of the [draft proposal] with respect to fall restraint systems would make it difficult for a person using a fall restraint system to perform the necessary work. The SERs also raised the possibility of safety problems associated with wearing a safety harness as opposed to a safety belt, such as an increased likelihood of the harness being snagged and as a result the employee being either pulled into a wood chipper while on the ground or pulled out of the bucket when it is lowered. The Panel recommends that OSHA consider and solicit comment on the alternative of making no changes to its existing fall protection requirements. [The Panel recommends that, i]f the provision is retained, OSHA should carefully examine the issue of whether the fall restraint system requirements in the draft make use of fall restraint systems unworkable in aerial lifts. [The Panel recommends that] OSHA * * * also consider the nonregulatory alternative of working with aerial device manufacturers and aerial device users (for example, electric and telecommunications utilities, painting and electrical contractors, tree-trimming firms) in the development of improved fall restraint systems that are more comfortable than existing systems and maintain the appropriate degree of protection for employees.	Over the course of the rulemaking, OSHA examined the issue of whether using fall restraint systems to protect employees working from aerial lifts was practical and explored with manufacturers the nonregulatory option of improving fall protection systems for use in aerial lifts. The final rule requires that employers ensure that employees use a fall restraint system or a personal fall arrest system when working from aerial lifts. The final rule also requires that employers ensure that employees use a personal fall arrest system, work-positioning equipment, or fall-restraint system, as appropriate, when working at elevated locations more than 1.2 meters (4 feet) above the ground on poles, towers, or similar structures if the employer does not provide other fall protection. See the discussion of final § 1926.954(b)(3)(ii) and (b)(3)(iii) in Section V, Summary and Explanation of the Final Rule, earlier in this preamble, for a discussion of comments received on the regulatory alternatives.

*OSHA took the Panel recommendations listed in the table directly from the Panel's report (Ex. 0019). OSHA made editorial modifications, as necessary, for the purpose of clarity. Any modifications to the original recommendations are nonsubstantive and clearly indicated.

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VII. Federalism

OSHA reviewed this final rule in accordance with the most recent Executive Order (E.O.) on Federalism (E.O. 13132, 64 FR 43255 (Aug. 10, 1999)). This E.O. requires that Federal agencies, to the extent possible, refrain from limiting State policy options, consult with States prior to taking any actions that would restrict State policy options, and take such actions only when clear constitutional authority exists and the problem is national in scope. E.O. 13132 provides for preemption of State law only with the expressed consent of Congress. Any such preemption must be limited to the extent possible.

Under Section 18 of the OSH Act, Congress expressly provides that States may adopt, with Federal approval, a plan for the development and enforcement of occupational safety and health standards; States that obtain Federal approval for such a plan are referred to as "State-plan States" (29 U.S.C. 667). Occupational safety and health standards developed by State-plan States must be at least as effective in providing safe and healthful employment and places of employment as the Federal standards. Subject to these requirements, State-plan States are free to develop and enforce under State law their own requirements for safety and health standards.

While OSHA drafted this final rule to protect employees in every State, Section 18(c)(2) of the Act permits State-plan States and Territories to develop and enforce their own standards for electric power generation, transmission, and distribution and electrical protective equipment provided that those requirements are at least as effective in providing safe and healthful employment and places of employment as the requirements in this final rule.

In summary, this final rule complies with E.O. 13132. In States without OSHA-approved State plans, this final rule limits State policy options in the same manner as every standard promulgated by OSHA. In States with OSHA-approved State plans, this rulemaking does not significantly limit State policy options.

VIII. Unfunded Mandates

OSHA reviewed this final rule according to the Unfunded Mandates Reform Act of 1995 (UMRA) (2 U.S.C. 1501 *et seq.*) and E.O. 13132 (64 FR 43255 (Aug. 10, 1999)). As discussed in the Final Economic and Regulatory Flexibility Analysis, OSHA estimates that compliance with the rule will require expenditures of less than $100 million per year by all affected employers. Therefore, this rule is not a significant regulatory action within the meaning of Section 202 of UMRA (2 U.S.C. 1532).

OSHA standards do not apply to State or local governments except in States that have elected voluntarily to adopt a State plan approved by the Agency. Consequently, the rule does not meet the definition of a "Federal intergovernmental mandate" (2 U.S.C. 658(5)).

Therefore, for the purposes of UMRA, the Agency certifies that this final rule does not mandate that State, local, or Tribal governments adopt new, unfunded regulatory obligations or increase expenditures by the private sector of more than $100 million in any year.

IX. Consultation and Coordination With Indian Tribal Governments

OSHA reviewed this final rule in accordance with Executive Order 13175, (65 FR 67249 (Nov. 9, 2000)) and determined that it does not have "tribal implications" as defined in that order. The final rule does not have substantial direct effects on one or more Indian tribes, on the relationship between the Federal government and Indian tribes, or on the distribution of power and responsibilities between the Federal government and Indian tribes.

X. Office of Management and Budget Review Under the Paperwork Reduction Act of 1995

The final rule revising the general industry and construction standards for electric power generation, transmission, and distribution, and for electrical protective equipment, contains collection of information requirements (paperwork) subject to review by OMB. In accordance with § 3506(c)(2) of the Paperwork Reduction Act of 1995 (44 U.S.C. 3501 *et seq.*), OSHA solicited comments on the information collections included in the proposal. For the proposal, the Department of Labor also submitted an information collection request to OMB for review in accordance with 44 U.S.C. 3507(d). OMB subsequently informed the Department of Labor that its "action [was] not an approval to conduct or sponsor an information collection under the Paperwork Reduction Act of 1995."

A. Information Collection Request for the Proposed Rule

In the information request for the proposal, OSHA submitted to OMB the following proposed new collections of information and proposed removing existing collections of information:

1. Proposed Electrical Protective Equipment in Construction Collections of Information

Proposed § 1926.97(c)(2)(xii) provided that the employer must certify that it tested equipment in accordance with the requirements of proposed paragraphs (c)(2)(iv), (c)(2)(vii)(C), (c)(2)(viii), (c)(2)(ix), and(c)(2)(xi) of that section and must ensure that the certification identified the equipment that passed the test and the date of the test; the provision also specified that marking the equipment and entering the results of the tests and the dates of testing in logs are two acceptable means of meeting these requirements.

2. Proposed Information-Transfer Collections of Information for General Industry and Construction

Proposed §§ 1926.950(c)(1)(i) and 1910.269(a)(4)(i)(A) provided that the host employer must inform the contractor of any known hazards that might be related to the contractor's work and that the contractor might not recognize; the host employer also must notify the contractor of any information needed to do assessments required by the standard.

Proposed §§ 1926.950(c)(1)(ii) and 1910.269(a)(4)(i)(B) provided that the host employer must report any observed contract-employer-related violations of the standards to the contract employer.

Proposed §§ 1926.950(c)(2)(iii) and 1910.269(a)(4)(ii)(C) provided that the contract employer must advise the host employer of unique hazards presented by the contract employer's work, unanticipated hazards found during the contract employer's work that the host employer did not mention, and measures the contractor took to correct and prevent recurrences of violations reported by the host employer.

3. Proposed Enclosed Spaces Collections of Information for Construction

Proposed § 1926.953(a) provided that, if, after the employer takes the precautions specified by §§ 1926.953 and 1926.965, the hazards remaining in the enclosed space endanger the life of an entrant or could interfere with escape from the space, then entry into the enclosed space must meet the permit-

space entry requirements of paragraphs (d) through (k) of § 1910.146.[575]

4. Proposed Removal of General Industry Training Certification

Existing § 1910.269(a)(2)(vii) requires the employer to certify that each employee received the training required by § 1910.269(a)(2). The employer must make this certification when the employee demonstrates proficiency in the work practices involved and maintain the certification for the duration of the employee's employment. OSHA proposed to remove the certification requirement contained in existing § 1910.269(a)(2)(vii).

B. Information Collection Requirements in the Final Rule

OSHA responded to public comments addressing the proposed rule's requirements in Section V, Summary and Explanation of the Final Rule, earlier in this preamble. Also, OSHA has submitted to OMB a new information collection request in connection with the final rule: a new information collection request in connection with the final rule titled "Supporting Statement for the Information Collection Requirements of the Electric Power Generation, Transmission, and Distribution Standards for Construction and General Industry (29 CFR 1926 Subpart V and 29 CFR 1910.269) and the Electrical Protective Equipment Standards for Construction and General Industry (29 CFR 1926.97and 29 CFR 1910.137)." This information collection request includes both the existing information collection requirements from the general industry standards and the new information collection requirements from the construction standards, resulting in a single information collection request for both the general industry and construction standards. Therefore, upon publication of the new information collection request, the Agency will discontinue the existing information collection request for the general industry standards titled "Supporting Statement for the Electrical Protective Equipment Standard (29 CFR 1910.137) and the Electric Power Generation, Transmission, and Distribution Standard (29 CFR 1910.269)," OMB Control Number 1218–0190.

The new information collection request contains several newly identified collections of information requirements in both construction and general industry (that is, collections of information not included in the information collection requests for either the proposal or existing §§ 1910.137 and 1910.269). As OSHA explains in detail in the new information collection request, the majority of the requirements covered by these newly identified collections of information consist of usual and customary practices with zero burden.

In addition to adding newly identified collections of information to the new information collection request, OSHA modified the following collections of information. First, the final electrical protective equipment provision for construction (final § 1926.97(c)(2)(xii)) requires, in addition to the collections of information noted in the information collection request for the proposal, that the employer make the required certification available upon request to the Assistant Secretary for Occupational Safety and Health and to employees and their authorized representatives. Second, as described in Section V, Summary and Explanation of the Final Rule, earlier in this preamble, the final information-transfer provisions for construction and general industry (final §§ 1926.950(c)(1) and (c)(2) and final §§ 1910.269(a)(3)(i) and (a)(3)(ii)) differ substantially from the proposal, and the information collection requests for §§ 1910.137 and 1910.269 and for § 1926.97 and Subpart V reflect these revisions.

Table 56 lists the provisions of the final rule that OSHA identified as containing collections of information.

TABLE 56—COLLECTIONS OF INFORMATION IN THE FINAL RULE

General Industry Standards	Construction Standards
§ 1910.137(c)(2)(xii)	§ 1926.97(c)(2)(xii)
§ 1910.269(a)(3)(i)	§ 1926.950(c)(1)
§ 1910.269(a)(3)(ii)	§ 1926.950(c)(2)
§ 1910.269(c)(1)(i)	§ 1926.952(a)(1)
§ 1910.269(d)(2)(iii)	NA
§ 1910.269(d)(2)(v)	NA
§ 1910.269(d)(2)(ix)	NA
§ 1910.269(d)(3)(ii)(F)	NA
§ 1910.269(d)(5)	NA
§ 1910.269(d)(8)(iv)	NA
NA	§ 1926.953(a)
NA	§ 1926.953(g)
§ 1910.269(f)	NA
§ 1910.269(l)(3)(ii)	§ 1926.960(c)(1)(ii)
§ 1910.269(m)(3)(i)	§ 1926.961(c)(1)
§ 1910.269(m)(3)(v)	§ 1926.961(c)(5)
§ 1910.269(m)(3)(ix)	§ 1926.961(c)(9)
§ 1910.269(m)(3)(x)(A)	§ 1926.961(c)(10)(i)
§ 1910.269(m)(3)(x)(D)	§ 1926.961(c)(10)(iv)
§ 1910.269(o)(3)(iii)(A)	§ 1926.963(c)(3)(i)
§ 1910.269(p)(4)(ii)	§ 1926.959(d)(2)
§ 1910.269(s)(1)(ii)	§ 1926.967(k)(1)(ii)
§ 1910.269(u)(4)(iv)	§ 1926.966(e)(4)
§ 1910.269(u)(6)(i)	§ 1926.966(g)(1)
§ 1910.269(v)(4)(iv)	NA
§ 1910.269(v)(7)(i)(A)	NA
§ 1910.269(v)(8)(i)	NA
§ 1910.269(v)(10)(i)	NA
§ 1910.269(v)(11)(ii)	NA
§ 1910.269(v)(11)(ix)	NA
§ 1910.269(v)(11)(x)	NA
§ 1910.269(v)(12)	NA
§ 1910.269(w)(6)(ii)	§ 1926.967(g)(2)

Note: "NA" = Not Applicable.

Before publishing this final rule, the Department of Labor submitted the new information collection request to OMB for its approval.[576] The new information collection request contains a full analysis and description of the burden hours and costs associated with paperwork requirements of the final rule. The public may obtain copies of the new information collection request on April 14, 2014 at *www.reginfo.gov* or by contacting OSHA at 202–693–2222. OSHA will publish a separate notice in the **Federal Register** that will announce the results of OMB's review and include in that notice any applicable OMB control number. Upon publication of that notice, any revisions to the new information collection request made as a result of OMB's review will be available at *www.reginfo.gov* by searching for the OMB-approved control number for the new information request.

The Department of Labor notes that a Federal agency cannot conduct or sponsor a collection of information unless OMB approves the collection of information under the Paperwork Reduction Act of 1995 and the information collection requirement displays a currently valid OMB control number. Also, notwithstanding any other provision of law, no employer may be subject to a penalty for failing to comply with a collection of information if the collection of information does not display a currently valid OMB control number.

XI. State-Plan Requirements

When Federal OSHA promulgates a new standard or more stringent amendment to an existing standard, the 27 States and U.S. Territories with their own OSHA-approved occupational safety and health plans must amend their standards to reflect the new standard or amendment, or show OSHA

[575] Some of the requirements in paragraphs (d) through (k) of § 1910.146 involve collections of information aimed at protecting employees from the hazards of entry into permit-required confined spaces. The proposal noted that § 1910.146 already has a control number.

[576] OSHA notes that 24,407 business or other for-profit establishments are affected by the final rule and estimates that there are no capital or start-up costs associated with the final rule's information collection requirements.

why such action is unnecessary, for example, because an existing State standard covering this area is "at least as effective" as the new Federal standard or amendment (29 CFR 1953.5(a)). The State standard must be at least as effective as the final Federal rule, must be applicable to both the private and public (State and local government employees) sectors, and must be completed within 6 months of the promulgation date of the final Federal rule. When OSHA promulgates a new standard or amendment that does not impose additional or more stringent requirements than an existing standard, State-Plan States are not required to amend their standards, although the Agency may encourage them to do so.

The 21 States and one U.S. Territory with OSHA-approved occupational safety and health plans covering private employers and State and local government employees are: Alaska, Arizona, California, Hawaii, Indiana, Iowa, Kentucky, Maryland, Michigan, Minnesota, Nevada, New Mexico, North Carolina, Oregon, Puerto Rico, South Carolina, Tennessee, Utah, Vermont, Virginia, Washington, and Wyoming. In addition, four States and one U.S. Territory have OSHA-approved State Plans that apply to State and local government employees only: Connecticut, Illinois, New Jersey, New York, and the Virgin Islands.

This final rule results in more stringent requirements for the work it covers. Therefore, States and Territories with OSHA-approved State Plans must adopt comparable amendments to their standards within 6 months of the promulgation date of this rule unless they demonstrate that such amendments are not necessary because their existing standards are at least as effective in protecting workers as this final rule. Each State Plan's existing requirements will continue to be in effect until it adopts the required revisions.

XII. Dates

When OSHA promulgates a final rule, the Agency typically provides a delay to allow employers to become familiar with the rule and to come into compliance. The Agency requested comments generally on what an appropriate delay would be for this rule, on how long employers would need to make purchases necessary for compliance with the proposed rule, and on the expected useful life of equipment that the proposal would have required employers to replace.

OSHA received a wide range of recommendations. A few commenters noted that the proposed rule was largely the same as existing § 1910.269 and suggested that employers would need minimal time to comply with the final rule. (See, for example, Exs. 0126, 0480.) BGE commented that employers would need 2 months "to evaluate the changes" (Ex. 0126). IBEW noted that the proposed changes would require only minimal new training and that employers could implement those changes within 6 months (Ex. 0480).

Many commenters stated that employers would need time to complete the budgetary process necessary to acquire funding for compliance and training. (See, for example, Exs. 0175, 0183, 0202, 0210, 0225, 0229, 0233, 0238, 0239, 0504.) One of these commenters suggested that OSHA should allow for one complete budget cycle (Ex. 0175). Another recommended a 3-year delay (Ex. 0238). The rest of these commenters recommended a 2-year delay. APPA maintained that small employers "will require additional time and budget allocations to execute any rules that may come from this process" and recommended that OSHA take this factor into consideration in adopting the final rule (Ex. 0504).

Siemens Power Generation commented that the proposed rules on protection from electric arcs were "so costly and onerous that they would require sophisticated employers two to three years to implement" (Ex. 0163). The company contended that small employers would need even more time so that they could "take advantage of OSHA outreach programs and obtain information from industry associations" (*id.*).

Ohio Rural Electric Cooperatives recommended at least a 2-year period "to replace and upgrade equipment," noting that "FR clothing in use at the time these change[s] become final will still have useable life before they need replacement" (Ex. 0186). The company noted that equipment currently in use provides a measure of protection even though it may not be compliant with the final rule (*id.*).

TVA recommended a 3-year delay for the requirement to estimate employee exposure to incident heat energy, explaining, "We recommend a three year delay . . . to complete estimation of heat energy exposures. This is based on our experience of performing calculations on plant and transmission circuits down to the 480 V board and panel level" (Ex. 0213).

TVA also recommended a 6- to 9-month delay for the arc-flash protection requirements,[577] commenting:

> To provide daily-wear FR clothing with an ATPV of 4 to 8 cal/cm² to meet the minimum proposed requirements for arc flash protection, we recommend a 6 to 9-month delay . . .. This recommendation is based on our experience of providing 3,600 employees five sets of daily-wear FR garments until we calculated the heat energy exposures. [*Id.*]

IBEW commented that the only purchases potentially requiring a delayed compliance deadline involve the acquisition of arc-rated clothing, although the union also stated that, "[b]ased on reports from protective clothing manufacturers and vendors, there is plenty of it to go around" (Ex. 0230). IBEW acknowledged that employers might need some time to implement new protective-clothing policies and recommended that the final rule provide no more than an 12-month delay in that regard (Tr. 899).

A few commenters, such as EEI, stated that, without knowing what the content of the final rule would be, they could not predict how long it would take to acquire new equipment, put it into place, and train employees in its use (Exs. 0177, 0209, 0227). These commenters recommended that OSHA consider their input after the Agency publishes the final rule.

OSHA believes that there will be little impact on the regulated community as a result of adopting requirements from existing § 1910.137 into new § 1926.97 or existing § 1910.269 into Subpart V. Almost all affected employers are already complying with these requirements. (See Section VI, Final Economic Analysis and Regulatory Flexibility Analysis, earlier in the preamble.) Additionally, many of the revisions in existing §§ 1910.137 and 1910.269 are clarifications of existing requirements or impose requirements that employers can implement quickly. For example, OSHA is revising provisions in existing § 1910.269(t) to cover vaults as well as manholes. The definitions of "manhole" and "vault" are so similar,[578] that OSHA believes that most employers already apply the relevant provisions to both manholes and vaults.

The Agency is setting a 90-day effective date for the final rule, although

[577] OSHA understands TVA's comment to indicate that it will take employers 6 to 9 months to purchase protective clothing and other protective equipment after they determine what protection to purchase.

[578] Existing § 1910.269(x) defines "manhole" as "[a] subsurface enclosure which personnel may enter and which is used for the purpose of installing, operating, and maintaining submersible equipment or cable." Existing § 1910.269(x) defines "vault" as "[a]n enclosure, above or below ground, which personnel may enter and which is used for the purpose of installing, operating, or maintaining equipment or cable." The only vaults addressed in § 1910.269(t), which applies to underground installations, are underground vaults.

OSHA will be imposing compliance deadlines more than 90 days after publication of the final rule for specific new or revised requirements, as explained later.

Four sets of requirements in the final rule set substantial new or revised duties on employers: The new requirements for transferring information between host employers and contract employers, revised provisions on the use of fall protection systems, revised requirements for minimum approach distances, and new requirements for protecting employees from the hazards associated with flames and electric arcs. As described in the following paragraphs, OSHA is adopting delayed compliance dates for some of these provisions:

A. The New Requirements for Transferring Information Between Host Employers and Contract Employers (§§ 1926.950(c) and 1910.269(a)(3))

Despite the controversy surrounding these provisions, OSHA believes that many host employers and contract employers already are implementing the practices required by final §§ 1926.950(c) and 1910.269(a)(3).[579] Additionally, the host-contractor provisions generally require the host employer and contract employer to provide information that they already have to each other, and the provisions do not require the outlay of any capital expenditures. Therefore, OSHA does not believe it is necessary to delay enforcement of these provisions beyond the effective date for the final rule. OSHA expects employers to be in compliance with the host-contractor requirements starting 90 days after publication of the final rule in the **Federal Register**.

B. Revised Provisions on the Use of Fall Protection Systems (§§ 1926.954(b)(3)(iii) and (b)(3)(iv) and 1910.269(g)(2)(iv)(C), and (g)(2)(iv)(D))

As discussed earlier under the summary and explanation for final § 1926.954(b)(3)(iii), some provisions in that paragraph and in final § 1910.269(g)(2)(iv)(C) have compliance deadlines. In §§ 1926.954(b)(3)(iii)(B) and 1910.269(g)(2)(iv)(C)(2), the final rule requires employees to use a personal fall arrest system, work-positioning equipment, or fall restraint system, as appropriate, when working at elevated locations more than 1.2 meters (4 feet) above the ground on poles, towers, or similar structures if the employer does not provide other fall protection meeting Subpart M of Part 1926. Paragraph (b)(3)(iii)(C) of § 1926.954 and paragraph (g)(2)(iv)(C)(3) of § 1910.269 provide exceptions to these general rules requiring fall protection. Paragraph (b)(3)(iii)(C) of § 1926.954 and paragraph (g)(2)(iv)(C)(3) of § 1910.269 provide that, until March 31, 2015, qualified employees need not use fall protection equipment for climbing or changing location on poles, towers, or similar structures, unless conditions could cause the employee to lose his or her grip or footing. After that date, qualified employees must use fall protection for climbing poles, towers, or similar structures, unless the employer can demonstrate that climbing with fall protection is infeasible or creates a greater hazard than climbing without it. Starting April 1, 2015, §§ 1926.954(b)(3)(iv) and 1910.269(g)(2)(iv)(D) require the employer to ensure that employees rig work-positioning systems so that the employee can free fall no more than 0.6 meters (2 feet).

C. Revised Requirements for Minimum Approach Distances (§§ 1926.960(c)(1) and 1910.269(l)(3))

As discussed in the summary and explanation for § 1926.960(c)(1), that provision in the final rule, and the comparable one in final § 1910.269(l)(3), set revised requirements for minimum approach distances. For voltages of 5.1 kilovolts and more, employers have until April 1, 2015, to comply with the revised provisions, including the requirement for employers to determine the maximum anticipated per-unit transient overvoltage, phase-to-ground, through an engineering analysis.

D. New Requirements for Protecting Employees From the Hazards Associated With Electric Arcs (§§ 1926.960(g) and 1910.269(l)(8))

Paragraph (g)(1) of final § 1926.960 and paragraph (l)(8)(i) of final § 1910.269 require the employer to assess the workplace to identify employees exposed to hazards from flames or from electric arcs. Although existing § 1910.269 does not explicitly require the employer to perform such an assessment, this requirement is implicit in existing § 1910.269(l)(6)(iii). This existing rule requires the employer to ensure that each employee exposed to the hazards of flames or electric arcs does not wear clothing that, when exposed to flames or electric arcs, could increase the extent of injury that would be sustained by the employee. To comply with this existing provision, the employer needs to determine if employees are exposed to hazards from flames or electric arcs. Consequently, OSHA concludes that employers already should be in substantial compliance with paragraphs (g)(1) of final § 1926.960 and (l)(8)(i) of final § 1910.269 and that no compliance delay beyond the effective date for the final rule is necessary.

Paragraph (g)(2) of final § 1926.960 and paragraph (l)(8)(ii) of final § 1910.269 provide that, for each employee exposed to hazards from electric arcs, the employer make a reasonable estimate of the incident heat energy to which the employee would be exposed. TVA's experience estimating incident energy for exposures at its electric power generation plants and transmission lines led them to recommend a 3-year delay for this element of the standard (*id.*). However, OSHA does not believe that TVA's experience forms a reasonable basis for setting compliance deadlines. In this regard, TVA indicated that it instituted measures to reduce energy below 100 cal/cm^2, including modifying some installations (Ex. 0213). OSHA believes that the initial incident-energy estimates conducted by TVA took only a fraction of the 3-year period and that the vast majority of this period involved retrofitting the circuits to reduce energy exposure below 100 cal/cm^2.

Mr. James Tomaseski with IBEW stated that the NESC was adopting requirements for a similar estimate of incident heat energy that was to become effective in 2009 (Tr. 898–899).[580] Mr. Brian Erga with ESCI stated that a delay of 12 to 18 months for OSHA's clothing-related provisions would be reasonable (Tr. 1275–1276). Based on Mr. Tomaseski's testimony, the Agency believes that most employers already have estimates of incident heat energy for many exposures. Moreover, the guidance provided in Appendix E should facilitate employers' efforts to complete these estimates. Consequently, the Agency concludes that a reasonable compliance date for the requirements to estimate incident heat energy under final §§ 1926.960(g)(2) and 1910.269(l)(8)(ii) is January 1, 2015.

Paragraph (g)(3) of final § 1926.960 and paragraph (l)(8)(iii) of final § 1910.269 require the employer to ensure that each employee exposed to hazards from flames or electric arcs does not wear clothing that could melt onto

[579] As the Agency noted in the preamble to the proposed rule, "Based on research conducted by CONSAD, OSHA believes that the communications that would be required by the proposed standards already occur for most affected projects" (70 FR 34911).

[580] Although the 2007 edition of the NESC to which Mr. Tomaseski referred was not final at the time of his testimony, the 2007 NESC ultimately set the effective date for its protective clothing provisions as January 1, 2009 (Ex. 0533).

his or her skin or that could ignite and continue to burn when exposed to flames or the heat energy estimated under §§ 1926.960(g)(2) and 1910.269(l)(8)(ii). Existing § 1910.269(l)(6)(iii) contains a comparable requirement without the reference to incident heat-energy estimates. As previously indicated, the final rule delays the requirements for incident heat-energy estimates until January 1, 2015. However, the Agency believes that it is important to continue the protection against clothing ignition contained in existing § 1910.269(l)(6)(iii). Therefore, OSHA is not setting a delayed compliance date for final §§ 1926.960(g)(3) and 1910.269(l)(8)(iii) beyond the effective date for the final rule. Until the employer completes the estimates required by final §§ 1926.960(g)(2) and 1910.269(l)(8)(ii), OSHA will enforce §§ 1926.960(g)(3) and 1910.269(l)(8)(iii) as it does existing § 1910.269(l)(6)(iii); that is, the clothing must not ignite and continue to burn when exposed to electric arcs the employee may encounter.

Paragraph (g)(4) of final § 1926.960 and paragraph (l)(8)(iv) of final § 1910.269 generally require the employer to ensure that the outer layer of clothing worn by an employees is flame resistant under specified conditions. The first three conditions are: (1) There is employee exposure to contact with energized circuit parts operating at more than 600 volts; (2) an electric arc could ignite flammable material in the work area that could, in turn, ignite the employee's clothing, and (3) molten metal or electric arcs from faulted conductors in the work area could ignite the employee's clothing. As a practical matter, the employer's assessment of employee exposure to hazards from flames or from electric arcs (as required by final §§ 1926.960(g)(1) and 1910.269(l)(8)(i)) will determine whether one or more of these conditions are present. As previously noted, the requirement for the employer to perform the assessment becomes effective with the rest of the rule, and OSHA determined that employers need no additional delay to comply with final §§ 1926.960(g)(4)(i) through (g)(4)(iii) and 1910.269(l)(8)(iv)(A) through (l)(8)(iv)(C).

Final §§ 1926.960(g)(4)(iv) and 1910.269(l)(8)(iv)(D) generally require flame-resistant clothing when the incident energy estimated under §§ 1926.960(g)(2) and 1910.269(l)(8)(ii) exceeds 2.0 cal/cm^2. This is a substantially new requirement, and compliance is dependent on completion of the incident heat-energy estimates required by §§ 1926.960(g)(2) and 1910.269(l)(8)(ii). As noted earlier, OSHA does not require compliance with the provisions on incident heat-energy estimates until January 1, 2015. Moreover, as explained later, OSHA is delaying requirements for arc-rated protection under final §§ 1926.960(g)(5) and 1910.269(l)(8)(v) until April 1, 2015. For these reasons, the Agency is adopting a compliance date for final §§ 1926.960(g)(4)(iv) and 1910.269(l)(8)(iv)(D) of April 1, 2015.

Final §§ 1926.960(g)(5) and 1910.269(l)(8)(v) provide that, with some exceptions, employers ensure that employees exposed to electric-arc hazards wear protective clothing and other protective equipment with an arc rating greater than or equal to the heat energy estimated under final §§ 1926.960(g)(2) and 1910.269(l)(8)(ii). Clearly, the employer must complete those incident heat-energy estimates before purchasing protection with an appropriate arc rating. Therefore, employers may delay complying with §§ 1926.960(g)(5) and 1910.269(l)(8)(v) until April 1, 2015. This delay provides employers additional time, when added to the period provided for estimating incident heat energy under §§ 1926.960(g)(2) and 1910.269(l)(8)(ii), to purchase compliant protective clothing and other protective equipment. The Agency could impose the same deadline for the requirements to estimate incident heat energy and to provide protective clothing and other protective equipment based those estimates; however, OSHA believes that having separate deadlines will ensure that employers have additional time after initially making estimates of heat energy to make necessary adjustments in work practices and circuit protection to reduce those estimates to a level where employers can use arc-rated protection with acceptably low arc ratings. If OSHA were to require compliance with both sets of requirements at the same time, employers initially might have to provide protection with high arc ratings. The dates adopted by this final rule provide employers with adequate time to ensure that incident heat-energy exposure levels for employees are as low as practical when the Agency begins enforcing §§ 1926.960(g)(5) and 1910.269(l)(8)(v).

The following table shows important compliance dates for the final rule.

The final rule becomes effective on July 10, 2014. Employer obligations under the specific provisions listed in this table commence on the dates indicated.

Requirement	Subpart V	§ 1910.269	Compliance date
Fall protection must be used by a qualified employee climbing or changing location on poles, towers, or similar structures unless the employer can demonstrate that climbing with fall protection is infeasible or creates a greater hazard than climbing or changing location without it.	§ 1926.954(b)(3)(iii)(C)	(g)(2)(iv)(C)(3)	April 1, 2015.
Work-positioning systems must be rigged so that an employee can free fall no more than 0.6 m (2 ft).	§ 1926.954(b)(3)(iv)	(g)(2)(iv)(D)	April 1, 2015.
Until the compliance deadline, employers may continue to use the minimum approach distances in existing Subpart V and § 1910.269 for voltages of 5.1 kilovolts and more. (Table 6 in Appendix B to Subpart V and in Table 6 through Table 13 in Appendix B to § 1910.269 specify the existing minimum approach distances.[1]) After the compliance deadline, employers must determine the maximum anticipated per-unit transient overvoltage, phase-to-ground in accordance with §§ 1926.960(c)(1)(ii) and 1910.269(l)(3)(ii) and must establish minimum approach distances in accordance with §§ 1926.960(c)(1)(i) and 1910.269(l)(3)(i).	§ 1926.960(c)(1) and Table V-2	(l)(3) and Table R-3	April 1, 2015.

Requirement	Subpart V	§ 1910.269	Compliance date
The employer must make a reasonable estimate of the incident heat energy to which the employee would be exposed.	§ 1926.960(g)(2)	(l)(8)(ii)	January 1, 2015.
The employer must ensure that the outer layer of clothing, except for clothing not required to be arc rated, is flame resistant when the estimated incident heat energy exceeds 2.0 cal/cm^2.	§§ 1926.960(g)(4)(iv)	(l)(8)(iv)(D)	April 1, 2015.
The employer must ensure that employees with exposure to electric-arc hazards wear protective clothing and other protective equipment with an arc rating greater than or equal to the estimated heat energy whenever that estimate exceeds 2.0 cal/cm^2.	§§ 1926.960(g)(5)	(l)(8)(v)	April 1, 2015.

[1] Table 6 in Appendix B to Subpart V and in Table 6 through Table 13 in Appendix B to § 1910.269 contain minimum approach distances that duplicate the minimum approach distances in Table V–1 and Table V–2 in existing Subpart V and Table R–6 through R–8 in existing § 1910.269. OSHA reformatted and deleted extraneous information from these tables in the final rule; however, the relevant distances are identical to the existing tables.

List of Subjects in 29 CFR Parts 1910 and 1926

Electric power, Fire prevention, Hazardous substances, Incorporation by reference, Occupational safety and health, Safety.

Authority and Signature

David Michaels, Ph.D., MPH, Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of Labor, 200 Constitution Ave. NW., Washington, DC 20210, authorized the preparation of this notice.

This action is taken pursuant to sections 3704 *et seq.*, Pub. L. 107–217, 116 STAT. 1062, (40 U.S.C. 3704 *et seq.*); sections 4, 6, and 8, Pub. L. 91–596, 84 STAT. 1590 (29 U.S.C. 653, 655, 657), Secretary of Labor's Order No. 1–2012 (77 FR 3912 (Jan. 25, 2012)), and 29 CFR Part 1911.

Signed at Washington, DC, on December 6, 2013.

David Michaels,

Assistant Secretary of Labor for Occupational Safety and Health.

Accordingly, the Occupational Safety and Health Administration amends Parts 1910 and 1926 of Title 29 of the Code of Federal Regulation as follows:

PART 1910—[AMENDED]

Subpart I—Personal Protective Equipment

■ 1. Revise the authority citation for Subpart I of part 1910 to read as follows:

Authority: 29 U.S.C. 653, 655, 657; Secretary of Labor's Order No. 12–71 (36 FR 8754), 8–76 (41 FR 25059), 9–83 (48 FR 35736), 1–90 (55 FR 9033), 6–96 (62 FR 111), 3–2000 (65 FR 50017), 5–2002 (67 FR 65008), 5–2007 (72 FR 31160), 4–2010 (75 FR 55355), or 1–2012 (77 FR 3912), as applicable, and 29 CFR Part 1911.

■ 2. Revise § 1910.136(a) to read as follows:

§ 1910.136 Foot protection.

(a) *General requirements.* The employer shall ensure that each affected employee uses protective footwear when working in areas where there is a danger of foot injuries due to falling or rolling objects, or objects piercing the sole, or when the use of protective footwear will protect the affected employee from an electrical hazard, such as a static-discharge or electric-shock hazard, that remains after the employer takes other necessary protective measures.

* * * * *

■ 3. Revise § 1910.137 to read as follows:

§ 1910.137 Electrical protective equipment.

(a) Design requirements for specific types of electrical protective equipment. Rubber insulating blankets, rubber insulating matting, rubber insulating covers, rubber insulating line hose, rubber insulating gloves, and rubber insulating sleeves shall meet the following requirements:

(1) *Manufacture and marking of rubber insulating equipment.* (i) Blankets, gloves, and sleeves shall be produced by a seamless process.

(ii) Each item shall be clearly marked as follows:

(A) Class 00 equipment shall be marked Class 00.

(B) Class 0 equipment shall be marked Class 0.

(C) Class 1 equipment shall be marked Class 1.

(D) Class 2 equipment shall be marked Class 2.

(E) Class 3 equipment shall be marked Class 3.

(F) Class 4 equipment shall be marked Class 4.

(G) Nonozone-resistant equipment shall be marked Type I.

(H) Ozone-resistant equipment shall be marked Type II.

(I) Other relevant markings, such as the manufacturer's identification and the size of the equipment, may also be provided.

(iii) Markings shall be nonconducting and shall be applied in such a manner as not to impair the insulating qualities of the equipment.

(iv) Markings on gloves shall be confined to the cuff portion of the glove.

(2) *Electrical requirements.* (i) Equipment shall be capable of withstanding the ac proof-test voltage specified in Table I–1 or the dc proof-test voltage specified in Table I–2.

(A) The proof test shall reliably indicate that the equipment can withstand the voltage involved.

(B) The test voltage shall be applied continuously for 3 minutes for equipment other than matting and shall be applied continuously for 1 minute for matting.

(C) Gloves shall also be capable of separately withstanding the ac proof-test voltage specified in Table I–1 after a 16-hour water soak. (See the note following paragraph (a)(3)(ii)(B) of this section.)

(ii) When the ac proof test is used on gloves, the 60-hertz proof-test current may not exceed the values specified in Table I–1 at any time during the test period.

(A) If the ac proof test is made at a frequency other than 60 hertz, the permissible proof-test current shall be computed from the direct ratio of the frequencies.

(B) For the test, gloves (right side out) shall be filled with tap water and immersed in water to a depth that is in accordance with Table I–3. Water shall be added to or removed from the glove, as necessary, so that the water level is the same inside and outside the glove.

(C) After the 16-hour water soak specified in paragraph (a)(2)(i)(C) of this section, the 60-hertz proof-test current may not exceed the values given in Table I–1 by more than 2 milliamperes.

(iii) Equipment that has been subjected to a minimum breakdown voltage test may not be used for electrical protection. (See the note following paragraph (a)(3)(ii)(B) of this section.)

(iv) Material used for Type II insulating equipment shall be capable of withstanding an ozone test, with no visible effects. The ozone test shall reliably indicate that the material will resist ozone exposure in actual use. Any visible signs of ozone deterioration of the material, such as checking, cracking, breaks, or pitting, is evidence of failure to meet the requirements for ozone-resistant material. (See the note following paragraph (a)(3)(ii)(B) of this section.)

(3) *Workmanship and finish.* (i) Equipment shall be free of physical irregularities that can adversely affect the insulating properties of the equipment and that can be detected by the tests or inspections required under this section.

(ii) Surface irregularities that may be present on all rubber goods (because of imperfections on forms or molds or because of inherent difficulties in the manufacturing process) and that may appear as indentations, protuberances, or imbedded foreign material are acceptable under the following conditions:

(A) The indentation or protuberance blends into a smooth slope when the material is stretched.

(B) Foreign material remains in place when the insulating material is folded and stretches with the insulating material surrounding it.

Note to paragraph (a): Rubber insulating equipment meeting the following national consensus standards is deemed to be in compliance with the performance requirements of paragraph (a) of this section:

American Society for Testing and Materials (ASTM) D120–09, *Standard Specification for Rubber Insulating Gloves.*

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.*

The preceding standards also contain specifications for conducting the various tests required in paragraph (a) of this section. For example, the ac and dc proof tests, the breakdown test, the water-soak procedure, and the ozone test mentioned in this paragraph are described in detail in these ASTM standards.

ASTM F1236–96 (2012), *Standard Guide for Visual Inspection of Electrical Protective Rubber Products,* presents methods and techniques for the visual inspection of electrical protective equipment made of rubber. This guide also contains descriptions and photographs of irregularities that can be found in this equipment.

ASTM F819–10, *Standard Terminology Relating to Electrical Protective Equipment for Workers,* includes definitions of terms relating to the electrical protective equipment covered under this section.

(b) *Design requirements for other types of electrical protective equipment.* The following requirements apply to the design and manufacture of electrical protective equipment that is not covered by paragraph (a) of this section:

(1) *Voltage withstand.* Insulating equipment used for the protection of employees shall be capable of withstanding, without failure, the voltages that may be imposed upon it.

Note to paragraph (b)(1): These voltages include transient overvoltages, such as switching surges, as well as nominal line voltage. See Appendix B to § 1910.269 for a discussion of transient overvoltages on electric power transmission and distribution systems. See IEEE Std 516–2009, *IEEE Guide for Maintenance Methods on Energized Power Lines,* for methods of determining the magnitude of transient overvoltages on an electrical system and for a discussion comparing the ability of insulation equipment to withstand a transient overvoltage based on its ability to withstand ac voltage testing.

(2) *Equipment current.* (i) Protective equipment used for the primary insulation of employees from energized circuit parts shall be capable of passing a current test when subjected to the highest nominal voltage on which the equipment is to be used.

(ii) When insulating equipment is tested in accordance with paragraph (b)(2)(i) of this section, the equipment current may not exceed 1 microampere per kilovolt of phase-to-phase applied voltage.

Note 1 to paragraph (b)(2): This paragraph applies to equipment that provides primary insulation of employees from energized parts. It does not apply to equipment used for secondary insulation or equipment used for brush contact only.

Note 2 to paragraph (b)(2): For ac excitation, this current consists of three components: Capacitive current because of the dielectric properties of the insulating material itself; conduction current through the volume of the insulating equipment; and leakage current along the surface of the tool or equipment. The conduction current is normally negligible. For clean, dry insulating equipment, the leakage current is small, and the capacitive current predominates.

Note to paragraph (b): Plastic guard equipment is deemed to conform to the performance requirements of paragraph (b) of this section if it meets, and is used in accordance with, ASTM F712–06 (2011), *Standard Test Methods and Specifications for Electrically Insulating Plastic Guard Equipment for Protection of Workers.*

(c) *In-service care and use of electrical protective equipment.* (1) *General.* Electrical protective equipment shall be maintained in a safe, reliable condition.

(2) *Specific requirements.* The following specific requirements apply to rubber insulating blankets, rubber insulating covers, rubber insulating line hose, rubber insulating gloves, and rubber insulating sleeves:

(i) Maximum use voltages shall conform to those listed in Table I–4.

(ii) Insulating equipment shall be inspected for damage before each day's use and immediately following any incident that can reasonably be suspected of causing damage. Insulating gloves shall be given an air test, along with the inspection.

Note to paragraph (c)(2)(ii): ASTM F1236–96 (2012), *Standard Guide for Visual Inspection of Electrical Protective Rubber Products,* presents methods and techniques for the visual inspection of electrical protective equipment made of rubber. This guide also contains descriptions and photographs of irregularities that can be found in this equipment.

(iii) Insulating equipment with any of the following defects may not be used:

(A) A hole, tear, puncture, or cut;

(B) Ozone cutting or ozone checking (that is, a series of interlacing cracks produced by ozone on rubber under mechanical stress);

(C) An embedded foreign object;

(D) Any of the following texture changes: swelling, softening, hardening, or becoming sticky or inelastic.

(E) Any other defect that damages the insulating properties.

(iv) Insulating equipment found to have other defects that might affect its insulating properties shall be removed from service and returned for testing under paragraphs (c)(2)(viii) and (c)(2)(ix) of this section.

(v) Insulating equipment shall be cleaned as needed to remove foreign substances.

(vi) Insulating equipment shall be stored in such a location and in such a manner as to protect it from light, temperature extremes, excessive humidity, ozone, and other damaging substances and conditions.

(vii) Protector gloves shall be worn over insulating gloves, except as follows:

(A) Protector gloves need not be used with Class 0 gloves, under limited-use conditions, when small equipment and parts manipulation necessitate unusually high finger dexterity.

Note to paragraph (c)(2)(vii)(A): Persons inspecting rubber insulating gloves used under these conditions need to take extra care in visually examining them. Employees using rubber insulating gloves under these conditions need to take extra care to avoid handling sharp objects.

(B) If the voltage does not exceed 250 volts, ac, or 375 volts, dc, protector gloves need not be used with Class 00 gloves, under limited-use conditions, when small equipment and parts manipulation necessitate unusually high finger dexterity.

Note to paragraph (c)(2)(vii)(B): Persons inspecting rubber insulating gloves used under these conditions need to take extra care in visually examining them. Employees using rubber insulating gloves under these conditions need to take extra care to avoid handling sharp objects.

(C) Any other class of glove may be used without protector gloves, under limited-use conditions, when small equipment and parts manipulation necessitate unusually high finger dexterity but only if the employer can demonstrate that the possibility of physical damage to the gloves is small and if the class of glove is one class higher than that required for the voltage involved.

(D) Insulating gloves that have been used without protector gloves may not be reused until they have been tested under the provisions of paragraphs (c)(2)(viii) and (c)(2)(ix) of this section.

(viii) Electrical protective equipment shall be subjected to periodic electrical tests. Test voltages and the maximum intervals between tests shall be in accordance with Table I–4 and Table I–5.

(ix) The test method used under paragraphs (c)(2)(viii) and (c)(2)(xi) of this section shall reliably indicate whether the insulating equipment can withstand the voltages involved.

Note to paragraph (c)(2)(ix): Standard electrical test methods considered as meeting this paragraph are given in the following national consensus standards:

ASTM D120–09, *Standard Specification for Rubber Insulating Gloves.*

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.*

(x) Insulating equipment failing to pass inspections or electrical tests may not be used by employees, except as follows:

(A) Rubber insulating line hose may be used in shorter lengths with the defective portion cut off.

(B) Rubber insulating blankets may be salvaged by severing the defective area from the undamaged portion of the blanket. The resulting undamaged area may not be smaller than 560 millimeters by 560 millimeters (22 inches by 22 inches) for Class 1, 2, 3, and 4 blankets.

(C) Rubber insulating blankets may be repaired using a compatible patch that results in physical and electrical properties equal to those of the blanket.

(D) Rubber insulating gloves and sleeves with minor physical defects, such as small cuts, tears, or punctures, may be repaired by the application of a compatible patch. Also, rubber insulating gloves and sleeves with minor surface blemishes may be repaired with a compatible liquid compound. The repaired area shall have electrical and physical properties equal to those of the surrounding material. Repairs to gloves are permitted only in the area between the wrist and the reinforced edge of the opening.

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

(xii) The employer shall certify that equipment has been tested in accordance with the requirements of paragraphs (c)(2)(iv), (c)(2)(vii)(D), (c)(2)(viii), (c)(2)(ix), and (c)(2)(xi) of this section. The certification shall identify the equipment that passed the test and the date it was tested and shall be made available upon request to the Assistant Secretary for Occupational Safety and Health and to employees or their authorized representatives.

Note to paragraph (c)(2)(xii): Marking equipment with, and entering onto logs, the results of the tests and the dates of testing are two acceptable means of meeting the certification requirement.

TABLE I–1—AC PROOF-TEST REQUIREMENTS

Class of Equipment	Proof-test Voltage rms V	Maximum proof-test current, mA (gloves only)			
		280-mm (11-in) glove	360-mm (14-in) glove	410-mm (16-in) glove	460-mm (18-in) glove
00	2,500	8	12	.....	.....
0	5,000	8	12	14	16
1	10,000	.....	14	16	18
2	20,000	.....	16	18	20
3	30,000	.....	18	20	22
4	40,000	.....	.....	22	24

TABLE I–2—DC PROOF-TEST REQUIREMENTS

Class of equipment	Proof-test voltage
00	10,000
0	20,000
1	40,000
2	50,000
3	60,000
4	70,000

Note: The dc voltages listed in this table are not appropriate for proof testing rubber insulating line hose or covers. For this equipment, dc proof tests shall use a voltage high enough to indicate that the equipment can be safely used at the voltages listed in Table I–4. See ASTM D1050–05 (2011) and ASTM D1049–98 (2010) for further information on proof tests for rubber insulating line hose and covers, respectively.

TABLE I–3—GLOVE TESTS—WATER LEVEL [1] [2]

Class of glove	AC proof test		DC proof test	
	mm	in	mm	in
00	38	1.5	38	1.5
0	38	1.5	38	1.5
1	38	1.5	51	2.0
2	64	2.5	76	3.0
3	89	3.5	102	4.0
4	127	5.0	153	6.0

[1] The water level is given as the clearance from the reinforced edge of the glove to the water line, with a tolerance of ±13 mm. (±0.5 in.).
[2] If atmospheric conditions make the specified clearances impractical, the clearances may be increased by a maximum of 25 mm. (1 in.).

TABLE I–4—RUBBER INSULATING EQUIPMENT, VOLTAGE REQUIREMENTS

Class of equipment	Maximum use voltage [1] AC rms	Retest voltage [2] AC rms	Retest voltage [2] DC avg
00	500	2,500	10,000
0	1,000	5,000	20,000
1	7,500	10,000	40,000
2	17,000	20,000	50,000
3	26,500	30,000	60,000
4	36,000	40,000	70,000

[1] The maximum use voltage is the ac voltage (rms) classification of the protective equipment that designates the maximum nominal design voltage of the energized system that may be safely worked. The nominal design voltage is equal to the phase-to-phase voltage on multiphase circuits. However, the phase-to-ground potential is considered to be the nominal design voltage if:
(1) There is no multiphase exposure in a system area and the voltage exposure is limited to the phase-to-ground potential, or
(2) The electric equipment and devices are insulated or isolated or both so that the multiphase exposure on a grounded wye circuit is removed.
[2] The proof-test voltage shall be applied continuously for at least 1 minute, but no more than 3 minutes.

TABLE I–5—RUBBER INSULATING EQUIPMENT, TEST INTERVALS

Type of equipment	When to test
Rubber insulating line hose	Upon indication that insulating value is suspect and after repair.
Rubber insulating covers	Upon indication that insulating value is suspect and after repair.
Rubber insulating blankets	Before first issue and every 12 months thereafter; [1] upon indication that insulating value is suspect; and after repair.
Rubber insulating gloves	Before first issue and every 6 months thereafter; [1] upon indication that insulating value is suspect; after repair; and after use without protectors.
Rubber insulating sleeves	Before first issue and every 12 months thereafter; [1] upon indication that insulating value is suspect; and after repair.

[1] If the insulating equipment has been electrically tested but not issued for service, the insulating equipment may not be placed into service unless it has been electrically tested within the previous 12 months.

■ 4. In Appendix B to Subpart I of Part 1910, revise the heading and paragraph 10 to read as follows:

Appendix B to Subpart I of Part 1910—Nonmandatory Compliance Guidelines for Hazard Assessment and Personal Protective Equipment Selection

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10. *Selection guidelines for foot protection.* Safety shoes and boots which meet the ANSI Z41–1991 Standard provide both impact and compression protection. Where necessary, safety shoes can be obtained which provide puncture protection. In some work situations, metatarsal protection should be provided, and in other special situations electrical conductive or insulating safety shoes would be appropriate.

Safety shoes or boots with impact protection would be required for carrying or handling materials such as packages, objects, parts or heavy tools, which could be dropped; and, for other activities where objects might fall onto the feet. Safety shoes or boots with compression protection would be required for work activities involving skid trucks (manual material handling carts) around bulk rolls (such as paper rolls) and around heavy pipes, all of which could potentially roll over an employee's feet. Safety shoes or boots with puncture protection would be required where sharp objects such as nails, wire, tacks, screws, large staples, scrap metal etc., could be stepped on by employees causing a foot injury. Electrically conductive shoes would be required as a supplementary form of protection for work activities in which there is a danger of fire or explosion from the discharge of static electricity. Electrical-hazard or dielectric footwear would be required as a supplementary form of protection when an employee standing on the ground is exposed to hazardous step or touch potential (the difference in electrical potential between the feet or between the hands and feet) or when primary forms of electrical protective equipment, such as rubber insulating gloves and blankets, do not provide complete protection for an employee standing on the ground.

Some occupations (not a complete list) for which foot protection should be routinely considered are: Shipping and receiving clerks, stock clerks, carpenters, electricians, machinists, mechanics and repairers, plumbers and pipe fitters, structural metal workers, assemblers, drywall installers and lathers, packers, wrappers, craters, punch and stamping press operators, sawyers, welders, laborers, freight handlers, gardeners and grounds-keepers, timber cutting and logging workers, stock handlers and warehouse laborers.

* * * * *

Subpart R—Special Industries

■ 5. Revise the authority citation for Subpart R of Part 1910 to read as follows:

Authority: 29 U.S.C. 653, 655, 657; Secretary of Labor's Order No. 12–71 (36 FR 8754), 8–76 (41 FR 25059), 9–83 (48 FR 35736), 1–90 (55 FR 9033), 6–96 (62 FR 111), 5–2007 (72 FR 31159), 4–2010 (75 FR 55355), or 1–2012 (77 FR 3912), as applicable; and 29 CFR Part 1911.

■ 6. Revise § 1910.269 to read as follows:

§ 1910.269 Electric power generation, transmission, and distribution.

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

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

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

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

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

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

(3) Chlorine and hydrogen systems;

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

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

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

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

(2) Paragraphs (a)(2), (a)(3), (b), (c), (g), (k), (p), and (r) of this section apply to line-clearance tree-trimming operations performed by line-clearance tree trimmers who are not qualified employees.

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

(A) To construction work, as defined in § 1910.12 of this part, except for line-clearance tree-trimming operations and work involving electric power generation installations as specified in § 1926.950(a)(3) of this chapter; or

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

Note 1 to paragraph (a)(1)(ii)(B): The Occupational Safety and Health Administration considers work practices conforming to §§ 1910.332 through 1910.335 as complying with the electrical safety-related work-practice requirements of § 1910.269 identified in Table 1 of Appendix A–2 to this section, provided that employers are performing the work on a generation or distribution installation meeting §§ 1910.303 through 1910.308. This table also identifies provisions in § 1910.269 that apply to work by qualified persons directly on, or associated with, installations of electric power generation, transmission, and distribution lines or equipment, regardless of compliance with §§ 1910.332 through 1910.335.

Note 2 to paragraph (a)(1)(ii)(B): The Occupational Safety and Health Administration considers work practices performed by qualified persons and conforming to § 1910.269 as complying with §§ 1910.333(c) and 1910.335.

(iii) This section applies in addition to all other applicable standards contained in this Part 1910. Employers covered under this section are not exempt from complying with other applicable provisions in Part 1910 by the operation of § 1910.5(c). Specific references in this section to other sections of Part 1910 are for emphasis only.

(2) *Training.* (i) All employees performing work covered by this section shall be trained as follows:

(A) Each employee shall be trained in, and familiar with, the safety-related work practices, safety procedures, and other safety requirements in this section that pertain to his or her job assignments.

(B) 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 section but that are related to his or her work and are necessary for his or her safety.

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

(ii) Each qualified employee shall also be trained and competent in:

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

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

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

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

(E) The recognition of electrical hazards to which the employee may be exposed and the skills and techniques necessary to control or avoid these hazards.

Note to paragraph (a)(2)(ii): For the purposes of this section, a person must have the training required by paragraph (a)(2)(ii) of this section to be considered a qualified person.

(iii) Each line-clearance tree trimmer who is not a qualified employee shall also be trained and competent in:

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

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

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

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

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

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

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

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

Note to paragraph (a)(2)(v)(C): 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.

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

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

(viii) 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 (a)(2) of this section.

Note 1 to paragraph (a)(2)(viii): 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 (a)(2)(viii): For an employee with previous training, an employer may determine that that employee has demonstrated the proficiency required by this paragraph using the following process:

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

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

(3) *Information transfer.*

(i) Before work begins, the host employer shall inform contract employers of:

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

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

(B) Conditions that are related to the safety of the work to be performed, that are listed in paragraphs (a)(4)(vi) through (a)(4)(viii) of this section, and that are known to the host employer;

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

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

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

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

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

(ii) Contract employers shall comply with the following requirements:

(A) 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 (a)(3)(i) of this section.

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

(C) 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 (a)(3)(i) of this section. The contract employer shall provide this information to the host employer within 2 working days after discovering the hazardous condition.

(iii) 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 section.

(4) *Existing characteristics and conditions.* Existing characteristics and

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

(i) The nominal voltages of lines and equipment,

(ii) The maximum switching-transient voltages,

(iii) The presence of hazardous induced voltages,

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

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

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

(vii) The condition of poles, and

(viii) Environmental conditions relating to safety.

(b) *Medical services and first aid.* The employer shall provide medical services and first aid as required in § 1910.151. In addition to the requirements of § 1910.151, the following requirements also apply:

(1) *First-aid training.* 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:

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

(ii) 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.

(2) *First-aid supplies.* First-aid supplies required by § 1910.151(b) shall be placed in weatherproof containers if the supplies could be exposed to the weather.

(3) *First-aid kits.* The employer shall maintain each first-aid kit, shall ensure that it is readily available for use, and shall inspect it frequently enough to ensure that expended items are replaced. The employer also shall inspect each first aid kit at least once per year.

(c) *Job briefing.* (1) *Before each job.* (i) 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 paragraph (a)(4) of this section.

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

(2) *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.

(3) *Number of briefings.* (i) 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.

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

(4) *Extent of briefing.* (i) 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.

(ii) A more extensive discussion shall be conducted:

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

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

Note to paragraph (c)(4): The briefing must address all the subjects listed in paragraph (c)(2) of this section.

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

(d) *Hazardous energy control (lockout/tagout) procedures.* (1) *Application.* The provisions of paragraph (d) of this section apply to the use of lockout/tagout procedures for the control of energy sources in installations for the purpose of electric power generation, including related equipment for communication or metering. Locking and tagging procedures for the deenergizing of electric energy sources which are used exclusively for purposes of transmission and distribution are addressed by paragraph (m) of this section.

Note to paragraph (d)(1): Installations in electric power generation facilities that are not an integral part of, or inextricably commingled with, power generation processes or equipment are covered under § 1910.147 and Subpart S of this part.

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

(ii) The employer's energy control program under paragraph (d)(2) of this section shall meet the following requirements:

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

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

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

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

(C) After November 1, 1994, whenever replacement or major repair, renovation, or modification of a machine or equipment is performed, and whenever new machines or equipment are installed, energy isolating devices for such machines or equipment shall be designed to accept a lockout device.

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

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

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

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

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

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

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

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

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

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

(D) Where tagout is used for energy control, the periodic inspection shall include a review, between the inspector and each authorized and affected employee, of that employee's responsibilities under the energy control procedure being inspected, and the elements set forth in paragraph (d)(2)(vii) of this section.

(E) The employer shall certify that the inspections required by paragraph (d)(2)(v) of this section have been accomplished. The certification shall identify the machine or equipment on which the energy control procedure was being used, the date of the inspection, the employees included in the inspection, and the person performing the inspection.

Note to paragraph (d)(2)(v)(E): If normal work schedule and operation records demonstrate adequate inspection activity and contain the required information, no additional certification is required.

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

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

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

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

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

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

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

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

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

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

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

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

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

(B) Retraining shall also be conducted whenever a periodic inspection under paragraph (d)(2)(v) of this section reveals, or whenever the employer has reason to believe, that there are deviations from or inadequacies in an employee's knowledge or use of the energy control procedures.

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

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

(3) *Protective materials and hardware.*

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

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

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

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

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

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

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

(D) Tagout devices, including their means of attachment, shall be substantial enough to prevent

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

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

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

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

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

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

Note to paragraph (d)(5): See also paragraph (d)(7) of this section, which requires that the second notification take place before the machine or equipment is reenergized.

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

(i) Before an authorized or affected employee turns off a machine or equipment, the authorized employee shall have knowledge of the type and magnitude of the energy, the hazards of the energy to be controlled, and the method or means to control the energy.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

(A) Clear the machine or equipment of tools and materials in accordance with paragraph (d)(7)(i) of this section;

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

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

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

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

(ii) When servicing or maintenance is performed by a crew, craft, department, or other group, they shall use a procedure which affords the employees a level of protection equivalent to that provided by the implementation of a personal lockout or tagout device. Group lockout or tagout devices shall be used in accordance with the procedures required by paragraphs (d)(2)(iii) and (d)(2)(iv) of this section including, but not limited to, the following specific requirements:

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

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

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

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

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

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

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

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

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

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

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

(e) *Enclosed spaces.* This paragraph 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 paragraph applies to routine entry into enclosed spaces in lieu of the permit-space entry requirements contained in paragraphs (d) through (k) of § 1910.146. If, after the employer takes the precautions given in paragraphs (e) and (t) of this section, the hazards remaining in the enclosed space endanger the life of an entrant or could interfere with an entrant's escape from the space, then entry into the enclosed space shall meet the permit-space entry requirements of paragraphs (d) through (k) of § 1910.146.

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

(2) *Training.* 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.

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

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

(5) *Removing covers.* When covers are removed from enclosed spaces, the opening 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.

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

(7) *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 (e)(7): See paragraph (t) of this section for additional requirements on attendants for work in manholes and vaults.

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

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

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

(11) *Ventilation, and monitoring 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 (e)(11): See the definition of "hazardous atmosphere" for guidance in determining whether a specific concentration of a substance is hazardous.

(12) *Specific ventilation requirements.* If continuous forced-air ventilation is used, it 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.

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

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

Note to paragraph (e)(14): See the definition of "hazardous atmosphere" for guidance in determining whether a specific concentration of a substance is hazardous.

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

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

(g) *Personal protective equipment.* (1) *General.* Personal protective equipment shall meet the requirements of Subpart I of this part.

Note to paragraph (g)(1) of this section: Paragraph (h) of § 1910.132 sets employer payment obligations for the personal protective equipment required by this section, including, but not limited to, the fall protection equipment required by paragraph (g)(2) of this section, the electrical protective equipment required by paragraph (l)(3) of this section, and the flame-resistant and arc-rated clothing and other protective equipment required by paragraph (l)(8) of this section.

(2) *Fall protection.* (i) Personal fall arrest systems shall meet the requirements of Subpart M of Part 1926 of this chapter.

(ii) Personal fall arrest equipment used by employees who are exposed to hazards from flames or electric arcs, as determined by the employer under paragraph (l)(8)(i) of this section, shall be capable of passing a drop test equivalent to that required by paragraph (g)(2)(iii)(L) of this section after exposure to an electric arc with a heat energy of 40±5 cal/cm^2.

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

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

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

(2) Hardware shall have a corrosion-resistant finish.

(3) Hardware surfaces shall be smooth and free of sharp edges.

(B) 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).

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

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

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

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

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

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

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

(2) 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 (g)(2)(iii)(G)(*1*) and (g)(2)(iii)(G)(*2*): Positioning straps that pass direct-current tests at equivalent voltages are considered as meeting this requirement.

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

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

(5) A flammability test in accordance with Table R–2.

TABLE R–2—FLAMMABILITY TEST

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

(H) 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.

(I) 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.

(J) 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.

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

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

(2) 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.

(3) 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).

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

(1) 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).

(2) 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.

(3) 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.

(4) 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.

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

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

Note to paragraph (g)(2)(iii) of this section: 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 (g)(2)(iii) of this section.

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

(A) 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 (g)(2)(iv)(A): Appendix F to this section contains guidelines for inspecting work-positioning equipment.

(B) Personal fall arrest systems shall be used in accordance with § 1926.502(d).

Note to paragraph (g)(2)(iv)(B): 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.

(C) The employer shall ensure that employees use fall protection systems as follows:

(1) Each employee working from an aerial lift shall use a fall restraint system or a personal fall arrest system. Paragraph (c)(2)(v) of § 1910.67 does not apply.

(2) Except as provided in paragraph (g)(2)(iv)(C)(3) 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 D of this part.

(3) 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 must use fall protection equipment unless the employer can demonstrate that climbing or changing location with fall protection is infeasible or creates a greater hazard than climbing or changing location without it.

Note 1 to paragraphs (g)(2)(iv)(C)(2) and (g)(2)(iv)(C)(3): 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 D of this part contains the duty to provide fall protection associated with walking and working surfaces.

Note 2 to paragraphs (g)(2)(iv)(C)(2) and (g)(2)(iv)(C)(3): Until the employer ensures that employees are proficient in climbing and the use of fall protection under paragraph (a)(2)(viii) of this section, the employees are not considered "qualified employees" for the purposes of paragraphs (g)(2)(iv)(C)(*2*) and (g)(2)(iv)(C)(*3*) 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.

(D) 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).

(E) 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 kilonewtons (3,000 pounds-force), whichever is greater.

Note to paragraph (g)(2)(iv)(E): 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.

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

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

(2) To each other;

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

(4) To a horizontal lifeline; or

(5) 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.

(h) *Portable ladders and platforms.* (1) *General.* Requirements for portable ladders contained in Subpart D of this part apply in addition to the requirements of paragraph (h) of this section, except as specifically noted in paragraph (h)(2) of this section.

(2) *Special ladders and platforms.* Portable ladders used on structures or

conductors in conjunction with overhead line work need not meet § 1910.25(d)(2)(i) and (d)(2)(iii) or § 1910.26(c)(3)(iii). Portable ladders and platforms used on structures or conductors in conjunction with overhead line work shall meet the following requirements:

(i) 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.

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

(iii) Portable ladders and platforms shall be secured to prevent them from becoming dislodged.

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

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

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

(2) *Cord- and plug-connected equipment.* Cord- and plug-connected equipment not covered by Subpart S of this part shall comply with one of the following instead of § 1910.243(a)(5):

(i) 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

(ii) The equipment shall be of the double-insulated type conforming to Subpart S of this part; or

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

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

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

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

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

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

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

Note to paragraph (i)(4)(i): 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.

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

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

Note to paragraph (i)(4)(iii): 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.

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

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

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

(vii) Hoses may not be kinked.

(j) *Live-line tools.* (1) *Design of tools.* Live-line tool rods, tubes, and poles shall be designed and constructed to withstand the following minimum tests:

(i) 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 (j)(1)(i): 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 (j)(1) of this section.

(ii) 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

(iii) The tool shall withstand other tests that the employer can demonstrate are equivalent.

(2) *Condition of tools.* (i) Each live-line tool shall be wiped clean and visually inspected for defects before use each day.

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

(iii) Live-line tools used for primary employee protection shall be removed from service every 2 years, and whenever required under paragraph (j)(2)(ii) of this section, for examination, cleaning, repair, and testing as follows:

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

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

(C) The tool shall be tested in accordance with paragraphs (j)(2)(iii)(D) and (j)(2)(iii)(E) of this section under the following conditions:

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

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

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

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

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

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

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

Note to paragraph (j)(2): Guidelines for the examination, cleaning, repairing, and in-service testing of live-line tools are specified in the Institute of Electrical and Electronics Engineers' *IEEE Guide for Maintenance Methods on Energized Power Lines,* IEEE Std 516–2009.

(k) *Materials handling and storage.* (1) *General.* Materials handling and storage shall comply with applicable material-handling and material-storage requirements in this part, including those in Subpart N of this part.

(2) *Materials storage near energized lines or equipment.* (i) In areas to which access is not restricted to qualified persons only, materials or equipment may not be stored closer to energized lines or exposed energized parts of equipment than the following distances, plus a distance that provides for the maximum sag and side swing of all conductors and for the height and movement of material-handling equipment:

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

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

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

Note to paragraph (k)(2)(ii): Paragraphs (u)(1) and (v)(3) of this section specify the size of the working space.

(l) *Working on or near exposed energized parts.* This paragraph applies to work on exposed live parts, or near enough to them to expose the employee to any hazard they present.

(1) *General.* (i) Only qualified employees may work on or with exposed energized lines or parts of equipment.

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

(iii) Electric lines and equipment shall be considered and treated as energized unless they have been deenergized in accordance with paragraph (d) or (m) of this section.

(2) *At least two employees.* (i) Except as provided in paragraph (l)(2)(ii) of this section, at least two employees shall be present while any employees perform the following types of work:

(A) Installation, removal, or repair of lines energized at more than 600 volts,

(B) Installation, removal, or repair of deenergized lines if an employee is exposed to contact with other parts energized at more than 600 volts,

(C) Installation, removal, or repair of equipment, such as transformers, capacitors, and regulators, if an employee is exposed to contact with parts energized at more than 600 volts,

(D) Work involving the use of mechanical equipment, other than insulated aerial lifts, near parts energized at more than 600 volts, and

(E) Other work that exposes an employee to electrical hazards greater than, or equal to, the electrical hazards posed by operations listed specifically in paragraphs (l)(2)(i)(A) through (l)(2)(i)(D) of this section.

(ii) Paragraph (l)(2)(i) of this section does not apply to the following operations:

(A) Routine circuit switching, when the employer can demonstrate that conditions at the site allow safe performance of this work,

(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

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

(3) *Minimum approach distances.* (i) The employer shall establish minimum approach distances no less than the distances computed by Table R–3 for ac systems or Table R–8 for dc systems.

(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 R–9. 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 (l)(3)(ii): See Appendix B to this section for information on how to calculate the maximum anticipated per-unit transient overvoltage, phase-to-ground, when the employer uses portable protective gaps to reduce maximum transient overvoltages.

(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:

(A) The employee is insulated from the energized part (rubber insulating gloves or rubber insulating gloves and sleeves worn in accordance with paragraph (l)(4) 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

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

(C) The employee is insulated from any other exposed conductive object in accordance with the requirements for live-line barehand work in paragraph (q)(3) of this section.

(4) *Type of insulation.* (i) When an employee uses rubber insulating gloves as insulation from energized parts (under paragraph (l)(3)(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:

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

(B) When installing insulation for purposes of paragraph (l)(4)(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.

(ii) When an employee uses rubber insulating gloves or rubber insulating gloves and sleeves as insulation from energized parts (under paragraph (l)(3)(iii)(A) of this section), the employer shall ensure that the employee:

(A) Puts on the rubber insulating gloves and sleeves in a position where he or she cannot reach into the minimum approach distance, established by the employer under paragraph (l)(3)(i) of this section; and

(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 (l)(3)(i) of this section.

(5) *Working position.* (i) 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.

(ii) 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 paragraph (q)(3) of this section, the employee shall work from a position where he or she cannot reach into the minimum approach distance, established by the employer under paragraph (l)(3)(i) of this section.

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

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

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

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

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

(8) *Protection from flames and electric arcs.* (i) The employer shall assess the workplace to identify employees exposed to hazards from flames or from electric arcs.

(ii) 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 (l)(8)(ii): Appendix E to this section provides guidance on estimating available heat energy. The Occupational Safety and Health Administration will deem employers following the guidance in Appendix E to this section to be in compliance with paragraph (l)(8)(ii) of this section. An employer may choose a method of calculating incident heat energy not included in Appendix E to this section if the chosen method reasonably predicts the incident energy to which the employee would be exposed.

Note 2 to paragraph (l)(8)(ii): 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.

(iii) 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 (l)(8)(ii) of this section.

Note to paragraph (l)(8)(iii) of this section: 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.

(iv) 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 (l)(8)(v)(A) through (l)(8)(v)(E) of this section, is flame resistant under any of the following conditions:

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

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

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

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

(D) The incident heat energy estimated under paragraph (l)(8)(ii) of this section exceeds 2.0 cal/cm^2,

(v) 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 (l)(8)(ii) of this section whenever that estimate exceeds 2.0 cal/cm^2. This protective equipment shall cover the employee's entire body, except as follows:

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

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

(C) Arc-rated protection is not necessary for the employee's head when the employee is wearing head protection meeting § 1910.135 if the estimated incident energy is less than 9 cal/cm^2 for exposures involving single-phase arcs in open air or 5 cal/cm^2 for other exposures,

(D) The protection for the employee's head may consist of head protection meeting § 1910.135 and a faceshield with a minimum arc rating of 8 cal/cm^2 if the estimated incident-energy exposure is less than 13 cal/cm^2 for exposures involving single-phase arcs in open air or 9 cal/cm^2 for other exposures, and

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

Note to paragraph (l)(8): See Appendix E to this section for further information on the selection of appropriate protection.

(vi) Dates. (A) The obligation in paragraph (l)(8)(ii) of this section for the employer to make reasonable estimates of incident energy commences January 1, 2015.

(B) The obligation in paragraph (l)(8)(iv)(D) of this section for the employer to ensure that the outer layer of clothing worn by an employee is flame-resistant when the estimated incident heat energy exceeds 2.0 cal/cm^2 commences April 1, 2015.

(C) The obligation in paragraph (l)(8)(v) 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.

(9) *Fuse handling.* When an employee must install or remove fuses with one or both terminals energized at more than 300 volts, or with exposed parts energized at more than 50 volts, the

employer 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 I of this part, uses a tool rated for the voltage, and is clear of the exhaust path of the fuse barrel.

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

(11) *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.

(12) *Opening and closing circuits under load.* (i) The employer shall ensure that devices used by employees to open circuits under load conditions are designed to interrupt the current involved.

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

TABLE R–3—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 5 kV: [1]
$MAD = M + D$, where

D = 0.02 m	the electrical component of the minimum approach distance.
M = 0.31 m for voltages up to 750 V and 0.61 m otherwise	the inadvertent movement factor.

For phase-to-phase system voltages of 5.1 kV to 72.5 kV: [1] [4]
$MAD = M + AD$, where

M = 0.61 m	the inadvertent movement factor.
A = the applicable value from Table R–5	the altitude correction factor.
D = the value from Table R–4 corresponding to the voltage and exposure or the value of the electrical component of the minimum approach distance calculated using the method provided in Appendix B to this section.	the electrical component of the minimum approach distance.

For phase-to-phase system voltages of more than 72.5 kV, nominal: [2] [4]
$MAD = 0.3048(C +)V_{L\text{-}G}TA + M$, where

C = 0.01 for phase-to-ground exposures that the employer can demonstrate consist only of air across the approach distance (gap),
0.01 for phase-to-phase exposures if the employer can demonstrate that no insulated tool spans the gap and that no large conductive object is in the gap, or
0.011 otherwise

$V_{L\text{-}G}$ = 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 (l)(3)(ii) of this section; for phase-to-phase exposures, T equals $1.35T_{L\text{-}G} + 0.45$

A = altitude correction factor from Table R–5

M = 0.31 m, the inadvertent movement factor

a = saturation factor, as follows:

Phase-to-Ground Exposures

$V_{Peak} = T_{L\text{-}G}V_{L\text{-}G}\sqrt{2}$	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-Phase Exposures [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 R–6. If the worksite is at an elevation of more than 900 meters (3,000 feet), see footnote 1 to Table R–6.

[2] Employers may use the minimum approach distances in Table R–7, except that the employer may not use the minimum approach distances in Table R–7 for phase-to-phase exposures if an insulated tool spans the gap or if any large conductive object is in the gap. If the worksite is at an elevation of more than 900 meters (3,000 feet), see footnote 1 to Table R–7. Employers may use the minimum approach distances in Table 6 through Table 13 in Appendix B to this section, 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 object is in the gap.

[4] Until March 31, 2015, employers may use the minimum approach distances in Table 6 through Table 13 in Appendix B to this section.

TABLE R–4—ELECTRICAL COMPONENT OF THE MINIMUM APPROACH DISTANCE AT 5.1 TO 72.5 KV

[D; In meters]

Nominal voltage (kV) phase-to-phase	Phase-to-ground exposure	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 R–5—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 R–6—ALTERNATIVE MINIMUM APPROACH DISTANCES FOR VOLTAGES OF 72.5 KV AND LESS [1]

[In meters or feet and inches]

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

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

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

TABLE R–7—ALTERNATIVE MINIMUM APPROACH DISTANCES FOR VOLTAGES OF MORE THAN 72.5 KV [1 2 3]

[In meters or feet and inches]

Voltage range phase to phase (kV)	Phase-to-ground 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 R–5 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 R–8—DC LIVE-LINE MINIMUM APPROACH DISTANCE WITH OVERVOLTAGE FACTOR [1]

[In meters]

Maximum anticipated per-unit transient overvoltage	Distance (m) maximum line-to-ground voltage (kV)				
	250	400	500	600	750
1.5 or less	1.12	1.60	2.06	2.62	3.61
1.6	1.17	1.69	2.24	2.86	3.98
1.7	1.23	1.82	2.42	3.12	4.37
1.8	1.28	1.95	2.62	3.39	4.79

[1] The distances specified in this table are for air, 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 R–5 corresponding to the altitude of the work.

TABLE R–9—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

(m) *Deenergizing lines and equipment for employee protection.* (1) *Application.* Paragraph (m) of this section applies to the deenergizing of transmission and distribution lines and equipment for the purpose of protecting employees. See paragraph (d) of this section for requirements on the control of hazardous energy sources used in the generation of electric energy. Conductors and parts of electric equipment that have been deenergized under procedures other than those required by paragraph (d) or (m) of this section, as applicable, shall be treated as energized.

(2) *General.* (i) If a system operator is in charge of the lines or equipment and their means of disconnection, 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 (m)(3) of this section in the order specified.

(ii) 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 paragraph (m) of this section. All of the requirements of paragraph (m)(3) of this section apply, in the order specified, except as provided in paragraph (m)(2)(iii) of this section.

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

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

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

(B) Each crew shall independently comply with paragraph (m) of 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.

(v) 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.

(3) *Deenergizing lines and equipment.* (i) The employee that the employer designates pursuant to paragraph (m)(2) 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 (m)(3) of this section) and is responsible for the clearance.

(ii) 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.

(iii) 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.

(iv) The employer need not use the tags mentioned in paragraphs (m)(3)(ii) and (m)(3)(iii) of this section on a network protector for work on the primary feeder for the network protector's associated network transformer when the employer can demonstrate all of the following conditions:

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

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

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

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

(vi) After the applicable requirements in paragraphs (m)(3)(i) through (m)(3)(v) 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.

(vii) The employer shall ensure the installation of protective grounds as required by paragraph (n) of this section.

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

(ix) 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.

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

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

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

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

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

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

(xii) No one may remove tags without the release of the associated clearance as specified under paragraphs (m)(3)(x) and (m)(3)(xi) of this section.

(xiii) 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.

(n) *Grounding for the protection of employees.* (1) *Application.* Paragraph (n) of this section applies to grounding of generation, transmission, and distribution lines and equipment for the purpose of protecting employees. Paragraph (n)(4) of this section also applies to protective grounding of other equipment as required elsewhere in this section.

Note to paragraph (n)(1): This paragraph covers grounding of generation, transmission, and distribution lines and equipment when this section requires protective grounding and whenever the employer chooses to ground such lines and equipment for the protection of employees.

(2) *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 paragraph (m) of this section and shall ensure proper grounding of the lines or equipment as specified in paragraphs (n)(3) through (n)(8) 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:

(i) The employer ensures that the lines and equipment are deenergized under the provisions of paragraph (m) of this section.

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

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

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

Note to paragraph (n)(3): Appendix C to this section 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 (n)(3) of this section.

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

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

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

(5) *Testing.* The employer 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.

(6) *Connecting and removing grounds.* (i) 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.

(ii) 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.

(7) *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.

(8) *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.

(o) *Testing and test facilities.* (1) *Application.* Paragraph (o) of this section provides for safe work practices for high-voltage and high-power testing performed in laboratories, shops, and substations, and in the field and on electric transmission and distribution lines and equipment. It applies only to testing involving interim measurements 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 (o)(1): OSHA considers routine inspection and maintenance measurements made by qualified employees to be routine line work not included in the scope of paragraph (o) 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 section. Two typical examples of such excluded test work procedures are "phasing-out" testing and testing for a "no-voltage" condition.

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

(ii) 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 paragraph (a)(2) of this section.

(3) *Safeguarding of test areas.* (i) 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.

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

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

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

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

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

(iv) The employer shall ensure the removal of the safeguards required by paragraph (o)(3)(iii) of this section when employees no longer need the protection afforded by the safeguards.

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

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

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

(ii) 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.

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

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

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

Note to paragraph (o)(4)(iii)(B): See Appendix C to this section for information on measures that employers can take to protect employees from hazardous step and touch potentials.

(iv) 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.

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

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

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

(vi) 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.

(5) *Control and measuring circuits.* (i) 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.

(ii) 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.

(iii) 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.

(iv) 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.

(6) *Safety check.* (i) 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.

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

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

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

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

(D) Ground connections are clearly identifiable;

(E) Personal protective equipment is provided and used as required by Subpart I of this part and by this section; and

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

(p) *Mechanical equipment.* (1) *General requirements.* (i) The critical safety components of mechanical elevating and rotating equipment shall receive a thorough visual inspection before use on each shift.

Note to paragraph (p)(1)(i): 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.

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

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

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

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

(iv) 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.

(2) *Outriggers.* (i) Mobile equipment, if provided with outriggers, shall be operated with the outriggers extended and firmly set, except as provided in paragraph (p)(2)(iii) of this section.

(ii) 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.

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

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

(4) *Operations near energized lines or equipment.* (i) Mechanical equipment shall be operated so that the minimum approach distances, established by the employer under paragraph (l)(3)(i) of this section, 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.

(ii) 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 (p)(4)(i) of this section is reached, unless the employer can demonstrate that the operator can accurately determine that the minimum approach distance is being maintained.

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

(A) 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.

(B) 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 paragraph (l)(3)(i) of this section.

(C) 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:

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

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

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

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

Note to paragraph (p)(4)(iii)(C): Appendix C to this section contains information on hazardous step and touch potentials and on methods of protecting employees from hazards resulting from such potentials.

(q) *Overhead lines and live-line barehand work.* This paragraph provides additional requirements for work performed on or near overhead lines and equipment and for live-line barehand work.

(1) *General.* (i) 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 (q)(1)(i): Appendix D to this section 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.

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

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

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

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

(i) 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.

(ii) For conductors, cables, and pulling and tensioning equipment, the employer shall provide the protective measures required by paragraph (p)(4)(iii) of this section when employees are installing or removing a conductor or cable close enough to energized conductors that any of the following failures could energize the pulling or tensioning equipment or the conductor or cable being installed or removed:

(A) Failure of the pulling or tensioning equipment,

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

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

(iii) 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.

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

Note 2 to paragraph (q)(2)(iv): Appendix C to this section contains guidelines for protecting employees from hazardous differences in electric potential as required by this paragraph.

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

(vi) 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.

(vii) The employer shall repair or replace defective pulling lines and accessories.

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

(ix) 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.

(x) Employees may operate the pulling rig only when it is safe to do so.

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

(xi) While 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.

(3) *Live-line barehand work.* In addition to other applicable provisions contained in this section, the following requirements apply to live-line barehand work:

(i) 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 paragraph (a)(2) of this section in the technique and in the safety requirements of paragraph (q)(3) of this section.

(ii) 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 paragraph (a)(4) of this section:

(A) The nominal voltage rating of the circuit on which employees will perform the work,

(B) The clearances to ground of lines and other energized parts on which employees will perform the work, and

(C) The voltage limitations of equipment employees will use.

(iii) 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.

(iv) The employer shall ensure that employees keep tools and equipment clean and dry while they are in use.

(v) The employer shall render inoperable the automatic-reclosing feature of circuit-interrupting devices protecting the lines if the design of the devices permits.

(vi) 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 section. 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 (q)(3)(xiv) of this section, unless insulating guards cover the grounded objects and other lines and equipment.

Note to paragraph (q)(3)(vi): 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 section.

(vii) 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.

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

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

(viii) 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.

(ix) Aerial lifts used for live-line barehand work shall have dual controls (lower and upper) as follows:

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

(B) 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.

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

(xi) 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.

(xii) 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.

(xiii) 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.

(A) 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.

(B) The leakage current may not exceed 1 microampere per kilovolt of nominal phase-to-ground voltage.

(C) The employer shall immediately suspend work from the aerial lift when there is any indication of a malfunction in the equipment.

(xiv) The employer shall ensure that employees maintain the minimum approach distances, established by the employer under paragraph (l)(3)(i) of this section, 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.

(xv) 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 paragraph (l)(3)(i) of this section, 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.

(xvi) 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 paragraph (l)(3)(i) of this section, between all parts of the bucket and the grounded end of the bushing or insulator string or any other grounded surface.

(xvii) 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.

(xviii) 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.

(xix) 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.

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

(i) 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.

(ii) 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.

(iii) The employer shall ensure that employees do not detach the loadline from a member or section until they safely secure the load.

(iv) 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 section.

Note to paragraph (q)(4)(iv): 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 section.

(r) *Line-clearance tree trimming operations.* This paragraph provides additional requirements for line-clearance tree-trimming operations and for equipment used in these operations.

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

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

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

(A) If a line-clearance tree trimmer is to approach more closely than 3.05 meters (10 feet) to any conductor or electric apparatus energized at more than 750 volts or

(B) If branches or limbs being removed are closer to lines energized at more than 750 volts than the distances listed in Table R–5, Table R–6, Table R–7, and Table R–8 or

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

(iii) Line-clearance tree trimmers shall maintain the minimum approach distances from energized conductors given in Table R–5, Table R–6, Table R–7, and Table R–8.

(iv) Branches that are contacting exposed energized conductors or equipment or that are within the distances specified in Table R–5, Table R–6, Table R–7, and Table R–8 may be removed only through the use of insulating equipment.

Note to paragraph (r)(1)(iv): A tool constructed of a material that the employer can demonstrate has insulating qualities

meeting paragraph (j)(1) of this section is considered as insulated under paragraph (r)(1)(iv) of this section if the tool is clean and dry.

(v) Ladders, platforms, and aerial devices may not be brought closer to an energized part than the distances listed in Table R–5, Table R–6, Table R–7, and Table R–8.

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

Note to paragraph (r)(1)(vi): Thunderstorms in the immediate vicinity, high winds, snow storms, and ice storms are examples of adverse weather conditions that are presumed to make line-clearance tree trimming work too hazardous to perform safely.

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

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

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

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

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

(3) *Sprayers and related equipment.* (i) Walking and working surfaces of sprayers and related equipment shall be covered with slip-resistant material. If slipping hazards cannot be eliminated, slip-resistant footwear or handrails and stair rails meeting the requirements of Subpart D of this part may be used instead of slip-resistant material.

(ii) Equipment on which employees stand to spray while the vehicle is in motion shall be equipped with guardrails around the working area. The guardrail shall be constructed in accordance with Subpart D of this part.

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

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

(5) *Gasoline-engine power saws.* Gasoline-engine power saw operations shall meet the requirements of § 1910.266(e) and the following:

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

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

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

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

Note to paragraph (r)(5)(iv): Paragraph (e)(2)(vi) of § 1910.266 prohibits drop starting of chain saws.

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

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

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

(6) *Backpack power units for use in pruning and clearing.* (i) While a backpack power unit is running, no one other than the operator may be within 3.05 meters (10 feet) of the cutting head of a brush saw.

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

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

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

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

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

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

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

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

(vii) A rope that is wet, that is contaminated to the extent that its insulating capacity is impaired, or that is otherwise not considered to be insulated for the voltage involved may not be used near exposed energized lines.

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

(s) *Communication facilities.* (1) *Microwave transmission.* (i) The employer shall ensure that no employee looks into an open waveguide or antenna connected to an energized microwave source.

(ii) If the electromagnetic-radiation level within an accessible area associated with microwave communications systems exceeds the radiation-protection guide specified by § 1910.97(a)(2), the employer shall post the area with warning signs containing the warning symbol described in § 1910.97(a)(3). The lower half of the warning symbol shall include the following statements, or ones that the employer can demonstrate are equivalent: "Radiation in this area may exceed hazard limitations and special precautions are required. Obtain specific instruction before entering."

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

(2) *Power-line carrier.* 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 section pertaining to work on energized lines.

(t) *Underground electrical installations.* This paragraph provides additional requirements for work on underground electrical installations.

(1) *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.

(2) *Lowering equipment into manholes.* (i) 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.

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

(3) *Attendants for manholes and vaults.* (i) 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.

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

Note 1 to paragraph (t)(3)(ii): Paragraph (e)(7) of this section may also require an attendant and does not permit this attendant to enter the manhole or vault.

Note 2 to paragraph (t)(3)(ii): Paragraph (l)(1)(ii) of this section 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.

(iii) For the purpose of inspection, housekeeping, taking readings, or similar work, an employee working alone may enter, for brief periods of time, a manhole 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.

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

(4) *Duct rods.* The employer 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.

(5) *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.

(6) *Moving cables.* Except when paragraph (t)(7)(ii) 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.

(7) *Protection against faults.* (i) 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.

(ii) 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.

(8) *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.

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

(1) *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 (u)(1): American National Standard *National Electrical Safety Code,* ANSI/IEEE C2–2012 contains guidelines for the dimensions of access and working space about electric equipment in substations. Installations meeting the ANSI provisions comply with paragraph (u)(1) of this section. The Occupational Safety and Health Administration will determine whether an installation that does not conform to this ANSI standard complies with paragraph (u)(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 the configuration of the installation enables employees to maintain the minimum approach distances, established by the employer under paragraph (l)(3)(i) of this section, 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.

(2) *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.

(3) *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 (u)(3): IEEE Std 80–2000, *IEEE Guide for Safety in AC Substation Grounding,* contains guidelines for protection against hazardous differences in electric potential.

(4) *Guarding of rooms and other spaces containing electric supply equipment.* (i) Rooms and other spaces in which electric supply lines or equipment are installed shall meet the requirements of paragraphs (u)(4)(ii) through (u)(4)(v) of this section under the following conditions:

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

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

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

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

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

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

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

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

(v) 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.

(5) *Guarding of energized parts.* (i) 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 (u)(5)(i): 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 (u)(5)(i) 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 (u)(5)(i) 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.

(ii) 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.

(iii) 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.

(6) *Substation entry.* (i) 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.

(ii) The job briefing required by paragraph (c) of this section 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.

(v) *Power generation.* This paragraph provides additional requirements and related work practices for power generating plants.

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

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

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

(3) *Access and working space.* 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 (v)(3) of this section: 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 (v)(3) 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 (v)(3) 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 paragraph (l)(3)(i) of this section, 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.

(4) *Guarding of rooms and other spaces containing electric supply equipment.* (i) Rooms and other spaces in which electric supply lines or equipment are installed shall meet the requirements of paragraphs (v)(4)(ii) through (v)(4)(v) of this section under the following conditions:

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

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

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

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

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

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

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

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

(v) 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.

(5) *Guarding of energized parts.* (i) 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 (v)(5)(i): 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 (v)(5)(i) 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 (v)(5)(i) 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.

(ii) 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.

(iii) 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.

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

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

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

(7) *Chemical cleaning of boilers and pressure vessels.* The following requirements apply to chemical cleaning of boilers and pressure vessels:

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

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

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

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

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

Note to paragraph (v)(7)(iii): See § 1910.141 for requirements that apply to the water supply and to washing facilities.

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

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

Note to paragraph (v)(8)(i): See Subpart Z of this part for requirements necessary to protect the health of employees from the effects of chlorine.

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

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

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

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

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

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

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

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

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

(11) *Coal and ash handling.* (i) Only designated persons may operate railroad equipment.

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

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

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

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

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

(vii) The employer shall ensure that employees who work in coal- or ash-handling conveyor areas are trained and knowledgeable in conveyor operation and in the requirements of paragraphs (v)(11)(viii) through (v)(11)(xii) of this section.

(viii) Employees may not ride a coal- or ash-handling conveyor belt at any time. Employees may not cross over the conveyor belt, except at walkways, unless the conveyor's energy source has been deenergized and has been locked out or tagged in accordance with paragraph (d) of this section.

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

(x) If a conveyor that could cause injury when started is automatically controlled or is controlled from a remote location, an audible device shall be provided that sounds an alarm that will be recognized by each employee as a warning that the conveyor will start and

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

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

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

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

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

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

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

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

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

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

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

Note to paragraph (w)(1): See paragraphs (m) and (n) of this section for requirements pertaining to the deenergizing and grounding of capacitor installations.

(i) 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,

(ii) 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.

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

(2) *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.

(3) *Series streetlighting.* (i) If the open-circuit voltage exceeds 600 volts, the employer shall ensure that employees work on series streetlighting circuits in accordance with paragraph (q) or (t) of this section, as appropriate.

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

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

(5) *Protection against drowning.* (i) 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 U.S. Coast Guard-approved personal flotation device.

(ii) 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.

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

(6) *Employee protection in public work areas.* (i) Traffic-control signs and traffic-control devices used for the protection of employees shall meet § 1926.200(g)(2) of this chapter.

(ii) 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.

(iii) The employer shall use barricades where additional employee protection is necessary.

(iv) The employer shall protect excavated areas with barricades.

(v) The employer shall display warning lights prominently at night.

(7) *Backfeed.* When there is a possibility of voltage backfeed from sources of cogeneration or from the secondary system (for example, backfeed from more than one energized phase feeding a common load), the requirements of paragraph (l) of this section apply if employees will work the lines or equipment as energized, and the requirements of paragraphs (m) and (n) of this section apply if employees will work the lines or equipment as deenergized.

(8) *Lasers.* The employer shall install, adjust, and operate laser equipment in accordance with § 1926.54 of this chapter.

(9) *Hydraulic fluids.* Hydraulic fluids used for the insulated sections of

equipment shall provide insulation for the voltage involved.

(x) *Definitions.*

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

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

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

Automatic circuit recloser. A self-controlled device for 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 this section 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 section and who has sufficient knowledge of the construction and operation of the equipment, and the hazards involved, to perform his or her duties safely.

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 section. 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 section. Such spaces meet the definition of permit spaces in § 1910.146, 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 isolating device. A physical device that prevents the transmission or release of energy, including, but not limited to, the following: a manually operated electric circuit breaker, a disconnect switch, a manually operated switch, a slide gate, a slip blind, a line valve, blocks, and any similar device with a visible indication of the position of the device. (Push buttons, selector switches, and other control-circuit-type devices are not energy isolating devices.)

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

Entry (as used in paragraph (e) of this section). 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 G, *Occupational Health and Environmental Control,* or in Subpart Z, *Toxic and Hazardous Substances,* of this part and which could result in employee exposure in excess of its dose or permissible exposure limit;

Note 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, § 1910.1200, 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 this section.

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

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

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

Line-clearance tree trimming. The pruning, trimming, repairing, maintaining, removing, or clearing of trees, or the cutting of brush, that is within 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 section, 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 (l)(3)(i) of this section 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 (a)(2)(ii) of this section to be a qualified employee.

Note 2 to the definition of "qualified employee (qualified person)": Except under (g)(2)(iv)(C)(2) and (g)(2)(iv)(C)(3) of this section, 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 section, 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 section expresses voltages in nominal values, unless otherwise indicated. The nominal voltage of a system or circuit is the value assigned to a system or circuit of a given voltage class for the purpose of convenient designation. The operating voltage of the system may vary above or below this value.

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.

Appendix A to § 1910.269—Flow Charts

This appendix presents information, in the form of flow charts, that illustrates the scope and application of § 1910.269. This appendix addresses the interface between § 1910.269 and Subpart S of this Part (Electrical), between § 1910.269 and § 1910.146 (Permit-required confined spaces), and between § 1910.269 and § 1910.147 (The control of hazardous energy (lockout/tagout)). These flow charts provide guidance for employers trying to implement the requirements of § 1910.269 in combination with other General Industry Standards contained in Part 1910. Employers should always consult the relevant standards, in conjunction with this appendix, to ensure compliance with all applicable requirements.

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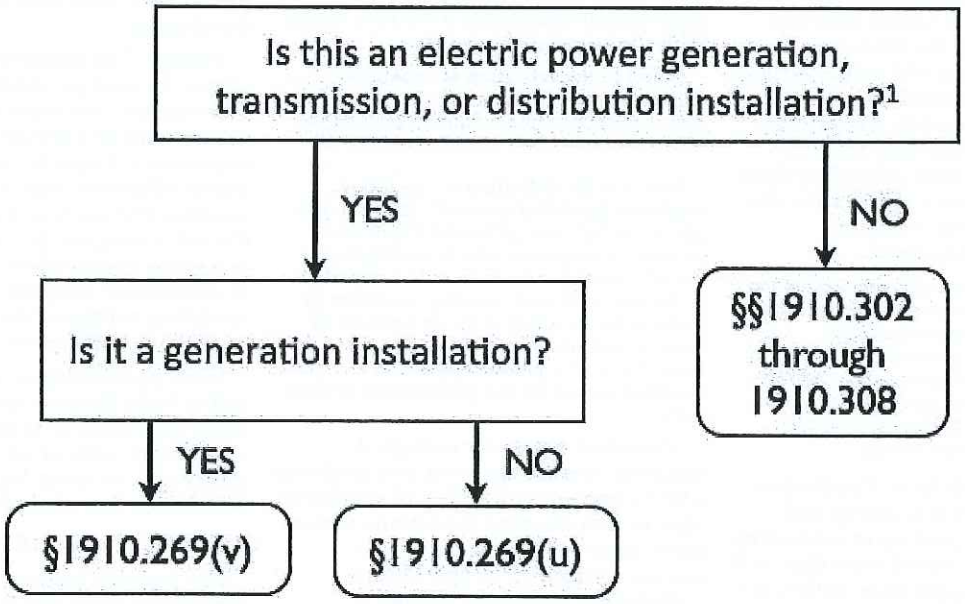
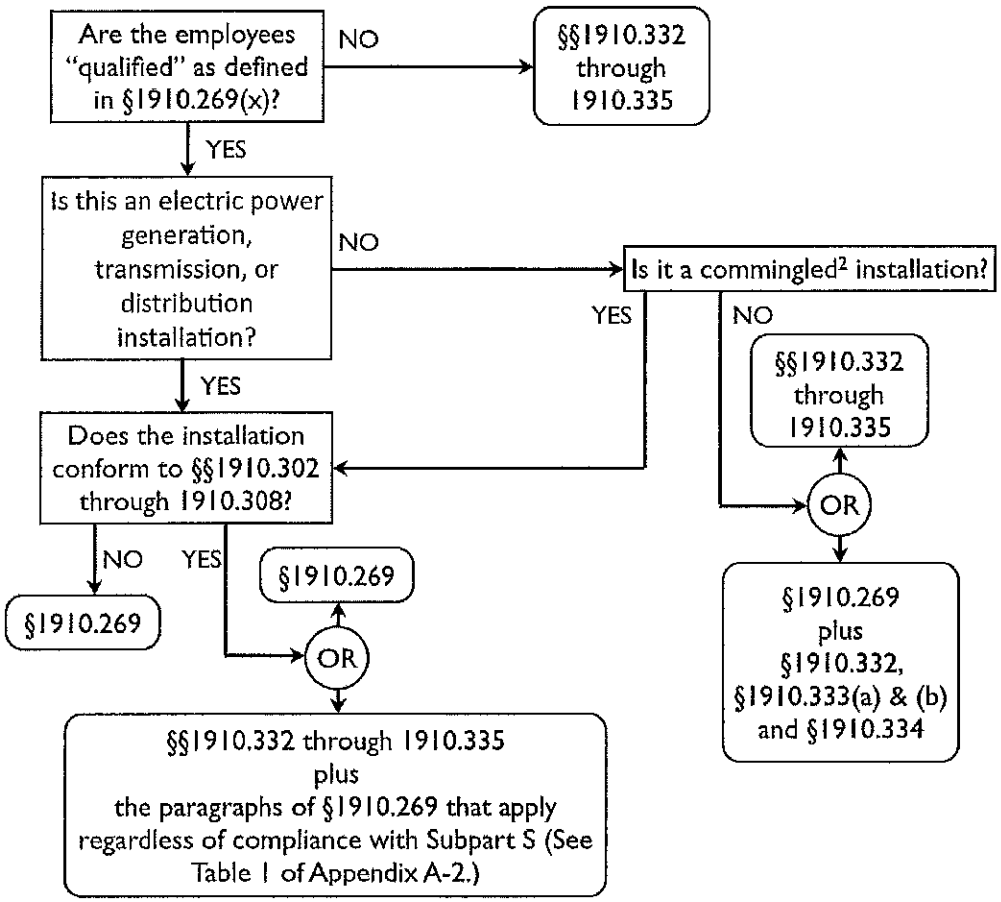
Appendix A-1 to §1910.269—Application of §1910.269 and Subpart S of this Part to the Design of Electrical Installations



[1]This chart applies to electrical installation design requirements only. See Appendix A-2 for electrical safety-related work practices. Supplementary electric generating equipment that is used to supply a workplace for emergency, standby, or similar purposes only is not considered an electric power generation installation.

Appendix A-2 to §1910.269— Application of §1910.269 and Subpart S of this Part to Electrical Safety-Related Work Practices[1]



[1]This flowchart applies only to the electrical safety-related work practice and training requirements in §1910.269 and §§1910.332 through 1910.335.

[2]This means commingled to the extent that the electric power generation, transmission, or distribution installation poses the greater hazard.

Table 1--Electrical Safety Requirements in §1910.269

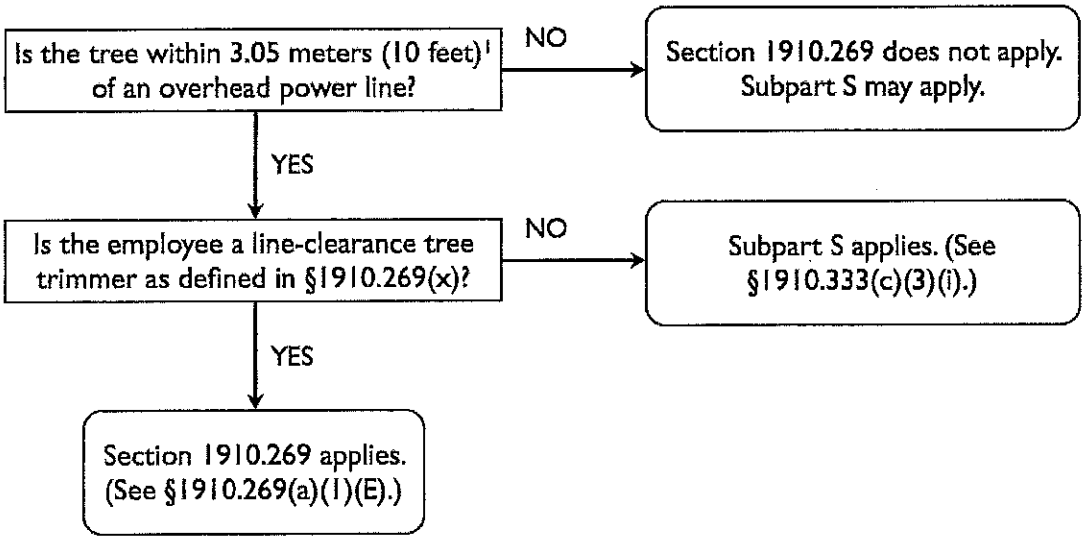
Compliance with Subpart S Will Comply with These Paragraphs of §1910.269[1]
(d), electric-shock hazards only
(h)(3)
(i)(2)
(k)
(l)(1) through (l)(4), (l)(6)(i), and (l)(8) through (l)(10)
(m)
(p)(4)
(s)(2)
(u)(1) and (u)(3) through (u)(5)
(v)(3) through (v)(5)
(w)(1) and (w)(7)

Paragraphs that Apply Regardless of Compliance with Subpart S[2]
(a)(2) and (a)(3)
(b)
(c)
(d), for other than electric-shock hazards
(e)
(f)
(g)
(h)(1) and (h)(2)
(i)(3) and (i)(4)
(j)
(l)(5), (l)(6)(ii), (l)(6)(iii), (l)(7), and (l)(11)
(n)
(o)
(p)(1) through (p)(3)
(q)
(r)
(s)(1)
(t)
(u)(2) and (u)(6)
(v)(1), (v)(2), and (v)(6) through (v)(12)
(w)(2) through (w)(6), (w)(8), and (w)(9)

[1]If the electrical installation meets the requirements of §§1910.302 through 1910.308 of this part, then the electrical installation and any associated electrical safety-related work practices conforming to §§1910.332 through 1910.335 of this part are considered to comply with these provisions of §1910.269 of this part.

[2]These provisions include electrical safety and other requirements that must be met regardless of compliance with Subpart S of this part.

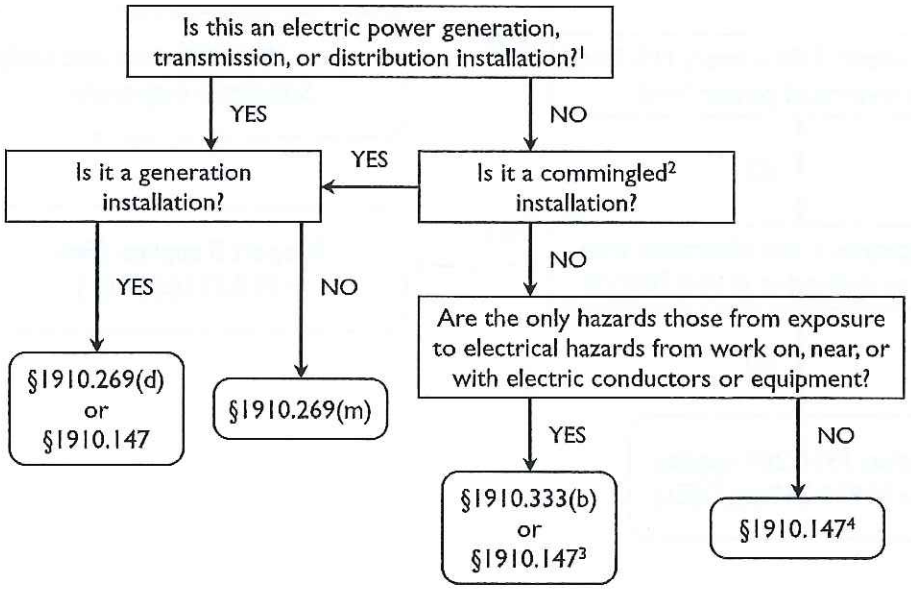
Appendix A-3 to §1910.269—Application of §1910.269 and Subpart S of this Part to Tree-Trimming Operations



[1] 3.05 meters (10 feet) plus 0.10 meters (4 inches) for every 10 kilovolts over 50 kilovolts.

Note: Paragraph (t) of §1910.269 contains additional requirements for work in manholes and underground vaults.

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



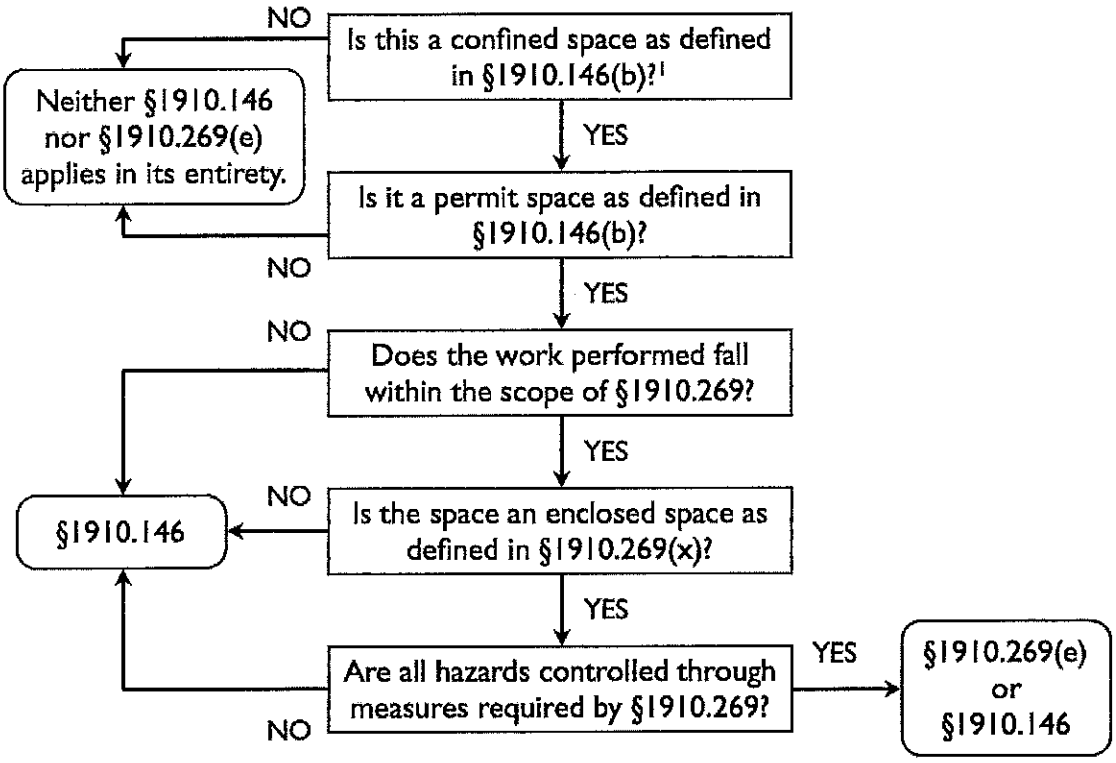
[1]If a generation, transmission, or distribution installation conforms to §§1910.302 through 1910.308, the lockout and tagging procedures of §1910.333(b) may be followed for electric-shock hazards.

[2]This means commingled to the extent that the electric power generation, transmission, or distribution installation poses the greater hazard.

[3]Paragraphs (b)(2)(iii)(D) and (b)(2)(iv)(B) of §1910.333 still apply.

[4]Paragraph (b) of §1910.333 applies to any electrical hazards from work on, near, or with electric conductors and equipment.

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



[1]See §1910.146(c) for general nonentry requirements that apply to all confined spaces.

Appendix B to § 1910.269—Working on Exposed Energized Parts

I. Introduction

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

The information in this appendix will assist employers in complying with the minimum approach-distance requirements contained in § 1910.269(l)(3) and (q)(3). Employers must use the technical criteria and methodology presented in this appendix in establishing minimum approach distances in accordance with § 1910.269(l)(3)(i) and Table R–3 and Table R–8. This appendix provides essential background information and technical criteria for the calculation of the required minimum approach distances for live-line work on electric power generation, transmission, and distribution installations.

Unless an employer is using the maximum transient overvoltages specified in Table R–9 for voltages over 72.5 kilovolts, the employer must use persons knowledgeable in the techniques discussed in this appendix, and competent in the field of electric transmission and distribution system design, to determine the maximum transient overvoltage.

II. General

A. *Definitions.* The following definitions from § 1910.269(x) relate to work on or near electric power generation, transmission, and distribution lines and equipment and the electrical hazards they present.

Exposed. . . . Not isolated or guarded.

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

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

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

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

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

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 (l)(3)(i) of § 1910.269 requires the employer to establish minimum approach distances no less than the distances computed by Table R–3 for ac systems so that employees can work safely without risk of sparkover.[2]

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

Normal system design may provide or include a means (such as lightning arrestors) to control maximum anticipated transient overvoltages, or the employer may use temporary devices (portable protective gaps) or measures (such as preventing automatic circuit breaker reclosing) to achieve the same result. Paragraph (l)(3)(ii) of § 1910.269 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 R–9, which specifies the following maximums for ac systems:

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

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

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

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

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

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

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

60 Hz Rod-to-Rod sparkover (kV peak)	Gap spacing from IEEE Std 4–1995 (cm)
25	2
36	3
46	4
53	5
60	6
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.

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.

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

[3] The withstand voltage is the voltage at which sparkover is not likely to occur across a specified distance. It is the voltage taken at the 3σ point below the sparkover voltage, assuming that the sparkover curve follows a normal distribution.

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

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

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

Equation 1—For Voltages of 72.6 kV to 800 kV

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

Where:

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

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

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

$V_{L\text{-}G}$ = Maximum system line-to-ground rms voltage in kilovolts—it should be the "actual" maximum, or the normal highest voltage for the range (for example, 10 percent above the nominal voltage); and

T = Maximum transient overvoltage factor in per unit.

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

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

TABLE 3—EQUATIONS FOR CALCULATING THE SURGE FACTOR, a

Phase-to-ground exposures			
$V_{Peak} = T_{L\text{-}G}V_{L\text{-}G}\sqrt{2}$	635 kV or less	635.1 to 915 kV	915.1 to 1,050 kV
a	0	$(V_{Peak}$- 635)/140,000	$(V_{Peak}$-645)/135,000
$V_{Peak} = T_{L\text{-}G}V_{L\text{-}G}\sqrt{2}$	More than 1,050 kV		
a	$(V_{Peak}$-675)/125,000		
Phase-to-phase exposures[1]			
$V_{Peak} = (1.35T_{L\text{-}G} + 0.45)V_{L\text{-}G}\sqrt{2}$	630 kV or less	630.1 to 848 kV	848.1 to 1,131 kV
a	0	$(V_{Peak}$-630)/155,000	$(V_{Peak}$-633.6)/152,207
$V_{Peak} = (1.35T_{L\text{-}G} + 0.45)V_{L\text{-}G}\sqrt{2}$	1,131.1 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, § 1910.269(l)(3)(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 R–9. For phase-to-ground exposures, the employer uses this value, called $T_{L\text{-}G}$, as T in Equation 1. IEEE Std 516–2009 provides the following formula to calculate the phase-to-phase maximum transient overvoltage, $T_{L\text{-}L}$, from $T_{L\text{-}G}$:

$T_{L\text{-}L} = 1.35T_{L\text{-}G} + 0.45$

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

D. *Provisions for inadvertent movement.* The minimum approach distance must include an "adder" to compensate for the inadvertent movement of the worker relative to an energized part or the movement of the part relative to the worker. This "adder" must account for this possible inadvertent movement and provide the worker with a comfortable and safe zone in which to work. Employers must add the distance for inadvertent movement (called the "ergonomic component of the minimum approach distance") to the electrical component to determine the total safe minimum approach distances used in live-line work.

The Occupational Safety and Health Administration based the ergonomic component of the minimum approach distance on response time-distance analysis. This technique uses an estimate of the total response time to a hazardous incident and converts that time to the distance traveled. For example, the driver of a car takes a given amount of time to respond to a "stimulus" and stop the vehicle. The elapsed time involved results in the car's traveling some distance before coming to a complete stop. This distance depends on the speed of the car

[4] Test data demonstrates that the saturation factor is greater than 0 at peak voltages of about 630 kilovolts. Systems operating at 345 kilovolts (or maximum system voltages of 362 kilovolts) can have peak maximum transient overvoltages exceeding 630 kilovolts. Table R–3 sets equations for calculating a based on peak voltage.

at the time the stimulus appears and the reaction time of the driver.

In the case of live-line work, the employee must first perceive that he or she is approaching the danger zone. Then, the worker responds to the danger and must decelerate and stop all motion toward the energized part. During the time it takes to stop, the employee will travel some distance. This is the distance the employer must add to the electrical component of the minimum approach distance to obtain the total safe minimum approach distance.

At voltages from 751 volts to 72.5 kilovolts,[5] the electrical component of the minimum approach distance is smaller than the ergonomic component. At 72.5 kilovolts, the electrical component is only a little more than 0.3 meters (1 foot). An ergonomic component of the minimum approach distance must provide for all the worker's unanticipated movements. At these voltages, workers generally use rubber insulating gloves; however, these gloves protect only a worker's hands and arms. Therefore, the energized object must be at a safe approach distance to protect the worker's face. In this case, 0.61 meters (2 feet) is a sufficient and practical ergonomic component of the minimum approach distance.

For voltages between 72.6 and 800 kilovolts, employees must use different work practices during energized line work. Generally, employees use live-line tools (hot sticks) to perform work on energized equipment. These tools, by design, keep the energized part at a constant distance from the employee and, thus, maintain the appropriate minimum approach distance automatically.

The location of the worker and the type of work methods the worker is using also influence the length of the ergonomic component of the minimum approach distance. In this higher voltage range, the employees use work methods that more tightly control their movements than when the workers perform work using rubber insulating gloves. The worker, therefore, is farther from the energized line or equipment and must be more precise in his or her movements just to perform the work. For these reasons, this section adopts an ergonomic component of the minimum approach distance of 0.31 m (1 foot) for voltages between 72.6 and 800 kilovolts.

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

TABLE 4—ERGONOMIC COMPONENT OF MINIMUM APPROACH DISTANCE

Voltage range (kV)	Distance	
	m	ft
0.301 to 0.750	0.31	1.0
0.751 to 72.5	0.61	2.0
72.6 to 800	0.31	1.0

Note: The employer must add this distance to the electrical component of the minimum approach distance to obtain the full minimum approach distance.

The ergonomic component of the minimum approach distance accounts for errors in maintaining the minimum approach distance (which might occur, for example, if an employee misjudges the length of a conductive object he or she is holding), and for errors in judging the minimum approach distance. The ergonomic component also accounts for inadvertent movements by the employee, such as slipping. In contrast, the working position selected to properly maintain the minimum approach distance must account for all of an employee's reasonably likely movements and still permit the employee to adhere to the applicable minimum approach distance. (See Figure 1.) Reasonably likely movements include an employee's adjustments to tools, equipment, and working positions and all movements needed to perform the work. For example, the employee should be able to perform all of the following actions without straying into the minimum approach distance:

- Adjust his or her hardhat,
- maneuver a tool onto an energized part with a reasonable amount of overreaching or underreaching,
- reach for and handle tools, material, and equipment passed to him or her, and
- adjust tools, and replace components on them, when necessary during the work procedure.

The training of qualified employees required under § 1910.269(a)(2), and the job planning and briefing required under § 1910.269(c), must address selection of a proper working position.

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[5] For voltages of 50 to 300 volts, Table R–3 specifies a minimum approach distance of "avoid contact." The minimum approach distance for this voltage range contains neither an electrical component nor an ergonomic component.

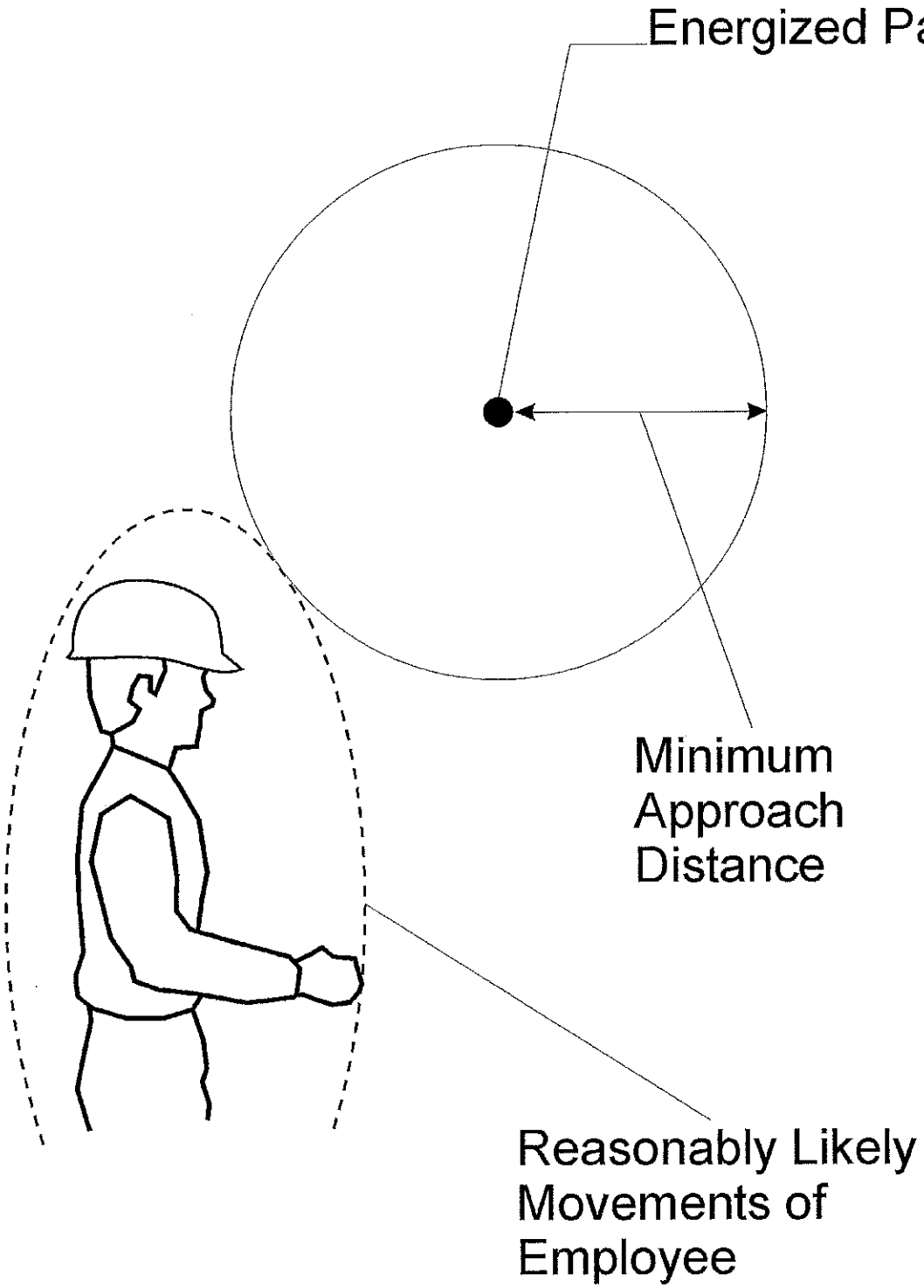

Figure 1—Maintaining the Minimum Approach Distance

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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

[6] For the purposes of estimating arc length, § 1910.269 generally assumes a more conservative dielectric strength of 10 kilovolts per 25.4 millimeters, consistent with assumptions made in consensus standards such as the National Electrical Safety Code (IEEE C2–2012). The more conservative value accounts for variables such as electrode shape, wave shape, and a certain amount of overvoltage.

characteristics of the applied voltage (wave shape) affect the disruptive gradient.

2. *Atmospheric effect.* The empirically determined electrical strength of a given gap is normally applicable at standard atmospheric conditions (20 °C, 101.3 kilopascals, 11 grams/cubic centimeter humidity). An increase in the density (humidity) of the air inhibits sparkover for a given air gap. The combination of temperature and air pressure that results in the lowest gap sparkover voltage is high temperature and low pressure. This combination of conditions is not likely to occur. Low air pressure, generally associated with high humidity, causes increased electrical strength. An average air pressure generally correlates with low humidity. Hot and dry working conditions normally result in reduced electrical strength. The equations for minimum approach distances in Table R–3 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 R–5 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 overvoltages.* Operation of switches or circuit breakers, a fault on a line or circuit or on an adjacent circuit, and similar activities may generate transient overvoltages on an electrical system. Each overvoltage has an associated transient voltage wave shape. The wave shape arriving at the site and its magnitude vary considerably.

In developing requirements for minimum approach distances, the Occupational Safety and Health Administration considered the most common wave shapes and the magnitude of transient overvoltages found on electric power generation, transmission, and distribution systems. The equations in Table R–3 for minimum approach distances use per-unit maximum transient overvoltages, which are relative to the nominal maximum voltage of the system. For example, a maximum transient overvoltage value of 3.0 per unit indicates that the highest transient overvoltage is 3.0 times the nominal maximum system voltage.

3. *Typical magnitude of overvoltages.* Table 5 lists the magnitude of typical transient overvoltages.

TABLE 5—MAGNITUDE OF TYPICAL TRANSIENT OVERVOLTAGES

Cause	Magnitude (per unit)
Energized 200-mile line without closing resistors	3.5
Energized 200-mile line with one-step closing resistor	2.1
Energized 200-mile line with multistep resistor	2.5
Reclosing with trapped charge one-step resistor	2.2
Opening surge with single restrike	3.0
Fault initiation unfaulted phase	2.1
Fault initiation adjacent circuit	2.5
Fault clearing	1.7 to 1.9

4. *Standard deviation—air-gap withstand.* For each air gap length under the same atmospheric conditions, there is a statistical variation in the breakdown voltage. The probability of breakdown against voltage has a normal (Gaussian) distribution. The standard deviation of this distribution varies with the wave shape, gap geometry, and atmospheric conditions. The withstand voltage of the air gap is three standard deviations (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 § 1910.269(x) depends on the maximum overvoltage possible at the worksite.

B. Minimum Approach Distances Based on Known, Maximum-Anticipated Per-Unit Transient Overvoltages

1. *Determining the minimum approach distance for AC systems.* Under § 1910.269(l)(3)(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-to-ground, in accordance with Table R–9. When the employer conducts an engineering analysis of the system and determines that the maximum transient overvoltage is lower than specified by Table R–9, 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 overvoltages) produces unacceptably large minimum approach distances:

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

Step 2. Determine the technique to use to control the maximum transient overvoltage. (See paragraphs IV.C and IV.D of this appendix.) Determine the maximum transient overvoltage that can exist at the worksite with that form of control in place and with a confidence level of 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 R–3.

C. Methods of Controlling Possible Transient Overvoltage Stress Found on a System

1. *Introduction.* There are several means of controlling overvoltages that occur on transmission systems. For example, the employer can modify the operation of circuit breakers or other switching devices to reduce switching transient overvoltages. Alternatively, the employer can hold the overvoltage to an acceptable level by installing surge arresters or portable

protective gaps on the system. In addition, the employer can change the transmission system to minimize the effect of switching operations. Section 4.8 of IEEE Std 516–2009 describes various ways of controlling, and thereby reducing, maximum transient overvoltages.

2. *Operation of circuit breakers.*[7] The maximum transient overvoltage that can reach the worksite is often the result of switching on the line on which employees are working. Disabling automatic reclosing during energized line work, so that the line will not be reenergized after being opened for any reason, limits the maximum switching surge overvoltage to the larger of the opening surge or the greatest possible fault-generated surge, provided that the devices (for example, insertion resistors) are operable and will function to limit the transient overvoltage and that circuit breaker restrikes do not occur. The employer must ensure the proper functioning of insertion resistors and other overvoltage-limiting devices when the employer's engineering analysis assumes their proper operation to limit the overvoltage level. If the employer cannot disable the reclosing feature (because of system operating conditions), other methods of controlling the switching surge level may be necessary.

Transient surges on an adjacent line, particularly for double circuit construction, may cause a significant overvoltage on the line on which employees are working. The employer's engineering analysis must account for coupling to adjacent lines.

3. *Surge arresters.* The use of modern surge arresters allows a reduction in the basic impulse-insulation levels of much transmission system equipment. The primary function of early arresters was to protect the system insulation from the effects of lightning. Modern arresters not only dissipate lightning-caused transients, but may also control many other system transients caused by switching or faults.

The employer may use properly designed arresters to control transient overvoltages along a transmission line and thereby reduce the requisite length of the insulator string and possibly the maximum transient overvoltage on the line.[8]

4. *Switching Restrictions.* Another form of overvoltage control involves establishing switching restrictions, whereby the employer prohibits the operation of circuit breakers until certain system conditions are present. The employer restricts switching by using a tagging system, similar to that used for a permit, except that the common term used for this activity is a "hold-off" or "restriction." These terms indicate that the restriction does not prevent operation, but only modifies the operation during the live-work activity.

D. Minimum Approach Distance Based on Control of Maximum Transient Overvoltage at the Worksite

When the employer institutes control of maximum transient overvoltage at the worksite by installing portable protective gaps, the employer may calculate the minimum approach distance as follows:

Step 1. Select the appropriate withstand voltage for the protective gap based on system requirements and an acceptable probability of gap sparkover.[9]

Step 2. Determine a gap distance that provides a withstand voltage[10] greater than or equal to the one selected in the first step.[11]

Step 3. Use 110 percent of the gap's critical sparkover voltage to determine the phase-to-ground peak voltage at gap sparkover ($V_{PPG\ Peak}$).

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

$$T = \frac{V_{PPG\,Peak}}{V_{L\text{-}G}\sqrt{2}}.$$

Step 5. Use this value of T[12] in the equation in Table R–3 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).

Sample protective gap calculations.

Problem: Employees are to perform work on a 500-kilovolt transmission line at sea level that is subject to transient overvoltages of 2.4 p.u. The maximum operating voltage of the line is 550 kilovolts. Determine the length of the protective gap that will provide the minimum practical safe approach distance. Also, determine what that minimum approach distance is.

Step 1. Calculate the smallest practical maximum transient overvoltage (1.25 times the crest phase-to-ground voltage):[13]

$$550kV \times \frac{\sqrt{2}}{\sqrt{3}} \times 1.25 = 561kV.$$

This value equals the withstand voltage of the protective gap.

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

$561kV \div 0.85 = 660kV$

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 R–3 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).

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 R–9, the employer must determine T at the worksite.

3. *Worksite.* If the employer installs protective gaps at the worksite, the gap setting establishes the worksite impulse insulation strength. Lightning strikes as far as 6 miles from the worksite can cause a voltage surge greater than the gap withstand voltage, and a gap sparkover can occur. In addition, the gap can sparkover from overvoltages on the line that exceed the withstand voltage of the gap. Consequently, the employer must protect employees from hazards resulting from any sparkover that could occur.

[7] The detailed design of a circuit interrupter, such as the design of the contacts, resistor insertion, and breaker timing control, are beyond the scope of this appendix. The design of the system generally accounts for these features. This appendix only discusses features that can limit the maximum switching transient overvoltage on a system.

[8] Surge arrester application is beyond the scope of this appendix. However, if the employer installs the arrester near the work site, the application would be similar to the protective gaps discussed in paragraph IV.D of this appendix.

[9] The employer should check the withstand voltage to ensure that it results in a probability of gap flashover that is acceptable from a system outage perspective. (In other words, a gap sparkover will produce a system outage. The employer should determine whether such an outage will impact overall system performance to an acceptable degree.) In general, the withstand voltage should be at least 1.25 times the maximum crest operating voltage.

[10] The manufacturer of the gap provides, based on test data, the critical sparkover voltage for each gap spacing (for example, a critical sparkover voltage of 665 kilovolts for a gap spacing of 1.2 meters). The withstand voltage for the gap is equal to 85 percent of its critical sparkover voltage.

[11] Switch steps 1 and 2 if the length of the protective gap is known.

[12] IEEE Std 516–2009 states that most employers add 0.2 to the calculated value of T as an additional safety factor.

[13] To eliminate sparkovers due to minor system disturbances, the employer should use a withstand voltage no lower than 1.25 p.u. Note that this is a practical, or operational, consideration only. It may be feasible for the employer to use lower values of withstand voltage.

F. *Disabling automatic reclosing.* There are two reasons to disable the automatic-reclosing feature of circuit-interrupting devices while employees are performing live-line work:

- To prevent reenergization of a circuit faulted during the work, which could create a hazard or result in more serious injuries or damage than the injuries or damage produced by the original fault;
- To prevent any transient overvoltage caused by the switching surge that would result if the circuit were reenergized.

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

V. Minimum Approach-Distance Tables

A. *Legacy tables.* Employers may use the minimum approach distances in Table 6 through Table 13 until March 31, 2015.

TABLE 6—MINIMUM APPROACH DISTANCES UNTIL MARCH 31, 2015

Voltage range phase to phase (kV)	Phase-to-ground exposure		Phase-to-phase exposure	
	m	ft	m	ft
0.05 to 1.0	Avoid Contact		Avoid Contact	
1.1 to 15.0	2.10	0.64	2.20	0.66
15.1 to 36.0	2.30	0.72	2.60	0.77
36.1 to 46.0	2.60	0.77	2.80	0.85
46.1 to 72.5	3.00	0.90	3.50	1.05
72.6 to 121	3.20	0.95	4.30	1.29
138 to 145	3.60	1.09	4.90	1.50
161 to 169	4.00	1.22	5.70	1.71
230 to 242	5.30	1.59	7.50	2.27
345 to 362	8.50	2.59	12.50	3.80
500 to 550	11.30	3.42	18.10	5.50
765 to 800	14.90	4.53	26.00	7.91

Note: The clear live-line tool distance must equal or exceed the values for the indicated voltage ranges.

TABLE 7—MINIMUM APPROACH DISTANCES UNTIL MARCH 31, 2015—72.6 TO 121.0 KV WITH OVERVOLTAGE FACTOR

T (p.u.)	Phase-to-ground exposure		Phase-to-phase exposure	
	m	ft	m	ft
2.0	0.74	2.42	1.09	3.58
2.1	0.76	2.50	1.09	3.58
2.2	0.79	2.58	1.12	3.67
2.3	0.81	2.67	1.14	3.75
2.4	0.84	2.75	1.17	3.83
2.5	0.84	2.75	1.19	3.92
2.6	0.86	2.83	1.22	4.00
2.7	0.89	2.92	1.24	4.08
2.8	0.91	3.00	1.24	4.08
2.9	0.94	3.08	1.27	4.17
3.0	0.97	3.17	1.30	4.25

Note 1: The employer may apply the distance specified in this table only where the employer determines the maximum anticipated per-unit transient overvoltage by engineering analysis. (Table 6 applies otherwise.)

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

TABLE 8—MINIMUM APPROACH DISTANCES UNTIL MARCH 31, 2015—121.1 TO 145.0 KV WITH OVERVOLTAGE FACTOR

T (p.u.)	Phase-to-ground exposure		Phase-to-phase exposure	
	m	ft	m	ft
2.0	0.84	2.75	1.24	4.08
2.1	0.86	2.83	1.27	4.17
2.2	0.89	2.92	1.30	4.25
2.3	0.91	3.00	1.32	4.33
2.4	0.94	3.08	1.35	4.42
2.5	0.97	3.17	1.37	4.50
2.6	0.99	3.25	1.40	4.58
2.7	1.02	3.33	1.42	4.67
2.8	1.04	3.42	1.45	4.75
2.9	1.07	3.50	1.47	4.83
3.0	1.09	3.58	1.50	4.92

Note 1: The employer may apply the distance specified in this table only where the employer determines the maximum anticipated per-unit transient overvoltage by engineering analysis. (Table 6 applies otherwise.)

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

TABLE 9—MINIMUM APPROACH DISTANCES UNTIL MARCH 31, 2015—145.1 TO 169.0 KV WITH OVERVOLTAGE FACTOR

T (p.u.)	Phase-to-ground exposure		Phase-to-phase exposure	
	m	ft	m	ft
2.0	0.91	3.00	1.42	4.67
2.1	0.97	3.17	1.45	4.75
2.2	0.99	3.25	1.47	4.83
2.3	1.02	3.33	1.50	4.92
2.4	1.04	3.42	1.52	5.00
2.5	1.07	3.50	1.57	5.17
2.6	1.12	3.67	1.60	5.25
2.7	1.14	3.75	1.63	5.33
2.8	1.17	3.83	1.65	5.42
2.9	1.19	3.92	1.68	5.50
3.0	1.22	4.00	1.73	5.67

Note 1: The employer may apply the distance specified in this table only where the employer determines the maximum anticipated per-unit transient overvoltage by engineering analysis. (Table 6 applies otherwise.)
Note 2: The distances specified in this table are the air, bare-hand, and live-line tool distances.

TABLE 10—MINIMUM APPROACH DISTANCES UNTIL MARCH 31, 2015—169.1 TO 242.0 KV WITH OVERVOLTAGE FACTOR

T (p.u.)	Phase-to-ground exposure		Phase-to-phase exposure	
	m	ft	m	ft
2.0	1.17	3.83	1.85	6.08
2.1	1.22	4.00	1.91	6.25
2.2	1.24	4.08	1.93	6.33
2.3	1.30	4.25	1.98	6.50
2.4	1.35	4.42	2.01	6.58
2.5	1.37	4.50	2.06	6.75
2.6	1.42	4.67	2.11	6.92
2.7	1.47	4.83	2.13	7.00
2.8	1.50	4.92	2.18	7.17
2.9	1.55	5.08	2.24	7.33
3.0	1.60	5.25	2.29	7.50

Note 1: The employer may apply the distance specified in this table only where the employer determines the maximum anticipated per-unit transient overvoltage by engineering analysis. (Table 6 applies otherwise.)
Note 2: The distances specified in this table are the air, bare-hand, and live-line tool distances.

TABLE 11—MINIMUM APPROACH DISTANCES UNTIL MARCH 31, 2015—242.1 TO 362.0 KV WITH OVERVOLTAGE FACTOR

T (p.u.)	Phase-to-ground exposure		Phase-to-phase exposure	
	m	ft	m	ft
2.0	1.60	5.25	2.62	8.58
2.1	1.65	5.42	2.69	8.83
2.2	1.75	5.75	2.79	9.17
2.3	1.85	6.08	2.90	9.50
2.4	1.93	6.33	3.02	9.92
2.5	2.03	6.67	3.15	10.33
2.6	2.16	7.08	3.28	10.75
2.7	2.26	7.42	3.40	11.17
2.8	2.36	7.75	3.53	11.58
2.9	2.49	8.17	3.68	12.08
3.0	2.59	8.50	3.81	12.50

Note 1: The employer may apply the distance specified in this table only where the employer determines the maximum anticipated per-unit transient overvoltage by engineering analysis. (Table 6 applies otherwise.)
Note 2: The distances specified in this table are the air, bare-hand, and live-line tool distances.

TABLE 12—MINIMUM APPROACH DISTANCES UNTIL MARCH 31, 2015—362.1 TO 552.0 KV WITH OVERVOLTAGE FACTOR

T (p.u.)	Phase-to-ground exposure		Phase-to-phase exposure	
	m	ft	m	ft
1.5	1.83	6.00	2.24	7.33
1.6	1.98	6.50	2.67	8.75
1.7	2.13	7.00	3.10	10.17
1.8	2.31	7.58	3.53	11.58
1.9	2.46	8.08	4.01	13.17
2.0	2.67	8.75	4.52	14.83

TABLE 12—MINIMUM APPROACH DISTANCES UNTIL MARCH 31, 2015—362.1 TO 552.0 KV WITH OVERVOLTAGE FACTOR—Continued

T (p.u.)	Phase-to-ground exposure		Phase-to-phase exposure	
	m	ft	m	ft
2.1	2.84	9.33	4.75	15.58
2.2	3.02	9.92	4.98	16.33
2.3	3.20	10.50	5.23	17.17
2.4	3.43	11.25	5.51	18.08

Note 1: The employer may apply the distance specified in this table only where the employer determines the maximum anticipated per-unit transient overvoltage by engineering analysis. (Table 6 applies otherwise.)
Note 2: The distances specified in this table are the air, bare-hand, and live-line tool distances.

TABLE 13—MINIMUM APPROACH DISTANCES UNTIL MARCH 31, 2015—552.1 TO 800.0 KV WITH OVERVOLTAGE FACTOR

T (p.u.)	Phase-to-ground exposure		Phase-to-phase exposure	
	m	ft	m	ft
1.5	2.95	9.67	3.68	12.08
1.6	3.25	10.67	4.42	14.50
1.7	3.56	11.67	5.23	17.17
1.8	3.86	12.67	6.07	19.92
1.9	4.19	13.75	6.99	22.92
2.0	4.55	14.92	7.92	26.00

Note 1: The employer may apply the distance specified in this table only where the employer determines the maximum anticipated per-unit transient overvoltage by engineering analysis. (Table 6 applies otherwise.)
Note 2: The distances specified in this table are the air, bare-hand, and live-line tool distances.

B. *Alternative minimum approach distances.* Employers may use the minimum approach distances in Table 14 through Table 21 provided that the employer follows the notes to those tables.

TABLE 14—AC MINIMUM APPROACH DISTANCES—72.6 TO 121.0 KV

T (p.u.)	Phase-to-ground exposure		Phase-to-phase exposure	
	m	ft	m	ft
1.5	0.67	2.2	0.84	2.8
1.6	0.69	2.3	0.87	2.9
1.7	0.71	2.3	0.90	3.0
1.8	0.74	2.4	0.93	3.1
1.9	0.76	2.5	0.96	3.1
2.0	0.78	2.6	0.99	3.2
2.1	0.81	2.7	1.01	3.3
2.2	0.83	2.7	1.04	3.4
2.3	0.85	2.8	1.07	3.5
2.4	0.88	2.9	1.10	3.6
2.5	0.90	3.0	1.13	3.7
2.6	0.92	3.0	1.16	3.8
2.7	0.95	3.1	1.19	3.9
2.8	0.97	3.2	1.22	4.0
2.9	0.99	3.2	1.24	4.1
3.0	1.02	3.3	1.27	4.2
3.1	1.04	3.4	1.30	4.3
3.2	1.06	3.5	1.33	4.4
3.3	1.09	3.6	1.36	4.5
3.4	1.11	3.6	1.39	4.6
3.5	1.13	3.7	1.42	4.7

TABLE 15—AC MINIMUM APPROACH DISTANCES—121.1 TO 145.0 KV

T (p.u.)	Phase-to-ground exposure		Phase-to-phase 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

TABLE 15—AC MINIMUM APPROACH DISTANCES—121.1 TO 145.0 KV—Continued

T (p.u.)	Phase-to-ground exposure		Phase-to-phase exposure	
	m	ft	m	ft
1.8	0.82	2.7	1.05	3.4
1.9	0.85	2.8	1.08	3.5
2.0	0.88	2.9	1.12	3.7
2.1	0.90	3.0	1.15	3.8
2.2	0.93	3.1	1.19	3.9
2.3	0.96	3.1	1.22	4.0
2.4	0.99	3.2	1.26	4.1
2.5	1.02	3.3	1.29	4.2
2.6	1.04	3.4	1.33	4.4
2.7	1.07	3.5	1.36	4.5
2.8	1.10	3.6	1.39	4.6
2.9	1.13	3.7	1.43	4.7
3.0	1.16	3.8	1.46	4.8
3.1	1.19	3.9	1.50	4.9
3.2	1.21	4.0	1.53	5.0
3.3	1.24	4.1	1.57	5.2
3.4	1.27	4.2	1.60	5.2
3.5	1.30	4.3	1.64	5.4

TABLE 16—AC MINIMUM APPROACH DISTANCES—145.1 TO 169.0 KV

T (p.u.)	Phase-to-ground exposure		Phase-to-phase exposure	
	m	ft	m	ft
1.5	0.81	2.7	1.05	3.4
1.6	0.84	2.8	1.09	3.6
1.7	0.87	2.9	1.13	3.7
1.8	0.90	3.0	1.17	3.8
1.9	0.94	3.1	1.21	4.0
2.0	0.97	3.2	1.25	4.1
2.1	1.00	3.3	1.29	4.2
2.2	1.03	3.4	1.33	4.4
2.3	1.07	3.5	1.37	4.5
2.4	1.10	3.6	1.41	4.6
2.5	1.13	3.7	1.45	4.8
2.6	1.17	3.8	1.49	4.9
2.7	1.20	3.9	1.53	5.0
2.8	1.23	4.0	1.57	5.2
2.9	1.26	4.1	1.61	5.3
3.0	1.30	4.3	1.65	5.4
3.1	1.33	4.4	1.70	5.6
3.2	1.36	4.5	1.76	5.8
3.3	1.39	4.6	1.82	6.0
3.4	1.43	4.7	1.88	6.2
3.5	1.46	4.8	1.94	6.4

TABLE 17—AC MINIMUM APPROACH DISTANCES—169.1 TO 242.0 KV

T (p.u.)	Phase-to-ground exposure		Phase-to-phase exposure	
	m	ft	m	ft
1.5	1.02	3.3	1.37	4.5
1.6	1.06	3.5	1.43	4.7
1.7	1.11	3.6	1.48	4.9
1.8	1.16	3.8	1.54	5.1
1.9	1.21	4.0	1.60	5.2
2.0	1.25	4.1	1.66	5.4
2.1	1.30	4.3	1.73	5.7
2.2	1.35	4.4	1.81	5.9
2.3	1.39	4.6	1.90	6.2
2.4	1.44	4.7	1.99	6.5
2.5	1.49	4.9	2.08	6.8
2.6	1.53	5.0	2.17	7.1
2.7	1.58	5.2	2.26	7.4
2.8	1.63	5.3	2.36	7.7
2.9	1.67	5.5	2.45	8.0
3.0	1.72	5.6	2.55	8.4

TABLE 17—AC MINIMUM APPROACH DISTANCES—169.1 TO 242.0 KV—Continued

T (p.u.)	Phase-to-ground exposure		Phase-to-phase exposure	
	m	ft	m	ft
3.1	1.77	5.8	2.65	8.7
3.2	1.81	5.9	2.76	9.1
3.3	1.88	6.2	2.86	9.4
3.4	1.95	6.4	2.97	9.7
3.5	2.01	6.6	3.08	10.1

TABLE 18—AC MINIMUM APPROACH DISTANCES—242.1 TO 362.0 KV

T (p.u.)	Phase-to-ground exposure		Phase-to-phase exposure	
	m	ft	m	ft
1.5	1.37	4.5	1.99	6.5
1.6	1.44	4.7	2.13	7.0
1.7	1.51	5.0	2.27	7.4
1.8	1.58	5.2	2.41	7.9
1.9	1.65	5.4	2.56	8.4
2.0	1.72	5.6	2.71	8.9
2.1	1.79	5.9	2.87	9.4
2.2	1.87	6.1	3.03	9.9
2.3	1.97	6.5	3.20	10.5
2.4	2.08	6.8	3.37	11.1
2.5	2.19	7.2	3.55	11.6
2.6	2.29	7.5	3.73	12.2
2.7	2.41	7.9	3.91	12.8
2.8	2.52	8.3	4.10	13.5
2.9	2.64	8.7	4.29	14.1
3.0	2.76	9.1	4.49	14.7
3.1	2.88	9.4	4.69	15.4
3.2	3.01	9.9	4.90	16.1
3.3	3.14	10.3	5.11	16.8
3.4	3.27	10.7	5.32	17.5
3.5	3.41	11.2	5.52	18.1

TABLE 19—AC MINIMUM APPROACH DISTANCES—362.1 TO 420.0 KV

T (p.u.)	Phase-to-ground exposure		Phase-to-phase exposure	
	m	ft	m	ft
1.5	1.53	5.0	2.40	7.9
1.6	1.62	5.3	2.58	8.5
1.7	1.70	5.6	2.75	9.0
1.8	1.78	5.8	2.94	9.6
1.9	1.88	6.2	3.13	10.3
2.0	1.99	6.5	3.33	10.9
2.1	2.12	7.0	3.53	11.6
2.2	2.24	7.3	3.74	12.3
2.3	2.37	7.8	3.95	13.0
2.4	2.50	8.2	4.17	13.7
2.5	2.64	8.7	4.40	14.4
2.6	2.78	9.1	4.63	15.2
2.7	2.93	9.6	4.87	16.0
2.8	3.07	10.1	5.11	16.8
2.9	3.23	10.6	5.36	17.6
3.0	3.38	11.1	5.59	18.3
3.1	3.55	11.6	5.82	19.1
3.2	3.72	12.2	6.07	19.9
3.3	3.89	12.8	6.31	20.7
3.4	4.07	13.4	6.56	21.5
3.5	4.25	13.9	6.81	22.3

TABLE 20—AC MINIMUM APPROACH DISTANCES—420.1 TO 550.0 KV

T (p.u.)	Phase-to-ground exposure		Phase-to-phase exposure	
	m	ft	m	ft
1.5	1.95	6.4	3.46	11.4
1.6	2.11	6.9	3.73	12.2
1.7	2.28	7.5	4.02	13.2
1.8	2.45	8.0	4.31	14.1
1.9	2.62	8.6	4.61	15.1
2.0	2.81	9.2	4.92	16.1
2.1	3.00	9.8	5.25	17.2
2.2	3.20	10.5	5.55	18.2
2.3	3.40	11.2	5.86	19.2
2.4	3.62	11.9	6.18	20.3
2.5	3.84	12.6	6.50	21.3
2.6	4.07	13.4	6.83	22.4
2.7	4.31	14.1	7.18	23.6
2.8	4.56	15.0	7.52	24.7
2.9	4.81	15.8	7.88	25.9
3.0	5.07	16.6	8.24	27.0

TABLE 21—AC MINIMUM APPROACH DISTANCES—550.1 TO 800.0 KV

T (p.u.)	Phase-to-ground exposure		Phase-to-phase exposure	
	m	ft	m	ft
1.5	3.16	10.4	5.97	19.6
1.6	3.46	11.4	6.43	21.1
1.7	3.78	12.4	6.92	22.7
1.8	4.12	13.5	7.42	24.3
1.9	4.47	14.7	7.93	26.0
2.0	4.83	15.8	8.47	27.8
2.1	5.21	17.1	9.02	29.6
2.2	5.61	18.4	9.58	31.4
2.3	6.02	19.8	10.16	33.3
2.4	6.44	21.1	10.76	35.3
2.5	6.88	22.6	11.38	37.3

Notes to Table 14 through Table 21:

1. The employer must determine the maximum anticipated per-unit transient overvoltage, phase-to-ground, through an engineering analysis, as required by § 1910.269(l)(3)(ii), or assume a maximum anticipated per-unit transient overvoltage, phase-to-ground, in accordance with Table R–9.
2. For phase-to-phase exposures, the employer must demonstrate that no insulated tool spans the gap and that no large conductive object is in the gap.
3. The worksite must be at an elevation of 900 meters (3,000 feet) or less above sea level.

Appendix C to § 1910.269—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" [14] 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.[15] In all cases, the degree of the hazard depends on the magnitude of the current through the employee and the time of exposure. This appendix discusses methods of protecting workers against the possibility that grounded objects, such as cranes and other mechanical equipment, will contact energized power lines and that deenergized and grounded power lines will become accidentally energized.

II. Voltage-Gradient Distribution

A. *Voltage-gradient distribution curve.* Absolute, or true, ground serves as a reference and always has a voltage of 0 volts above ground potential. Because there is an impedance between a grounding electrode and absolute ground, there will be a voltage difference between the grounding electrode and absolute ground under ground-fault conditions. Voltage dissipates from the grounding electrode (or from the grounding point) and creates a ground potential gradient. The voltage decreases rapidly with increasing distance from the grounding electrode. A voltage drop associated with this dissipation of voltage is a ground potential. Figure 1 is a typical voltage-gradient distribution curve (assuming a uniform soil texture).

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[14] 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.

[15] Thus, grounding systems for transmission towers and substation structures should be designed to minimize the step and touch potentials involved.

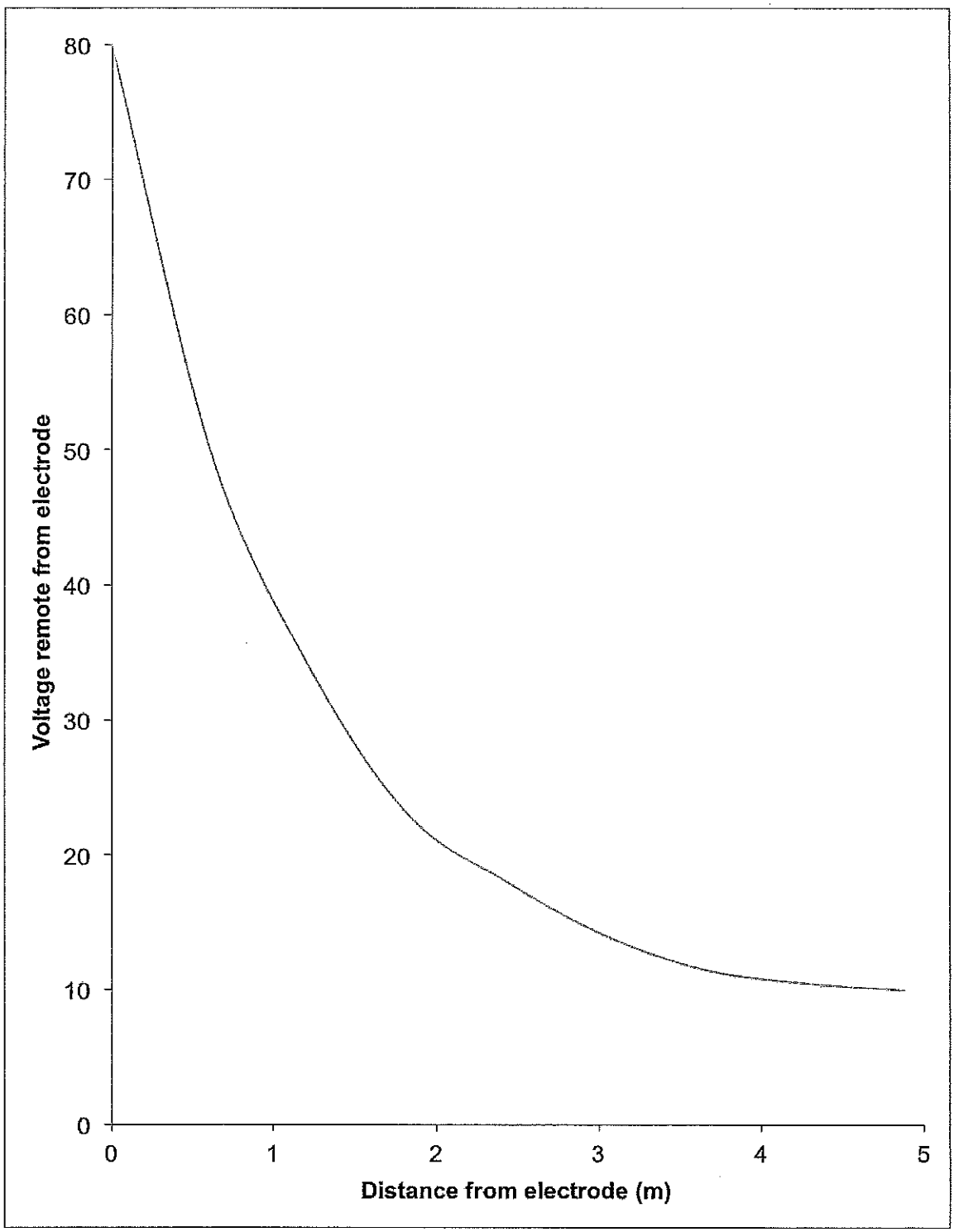

Figure 1—Typical Voltage-Gradient Distribution Curve

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.

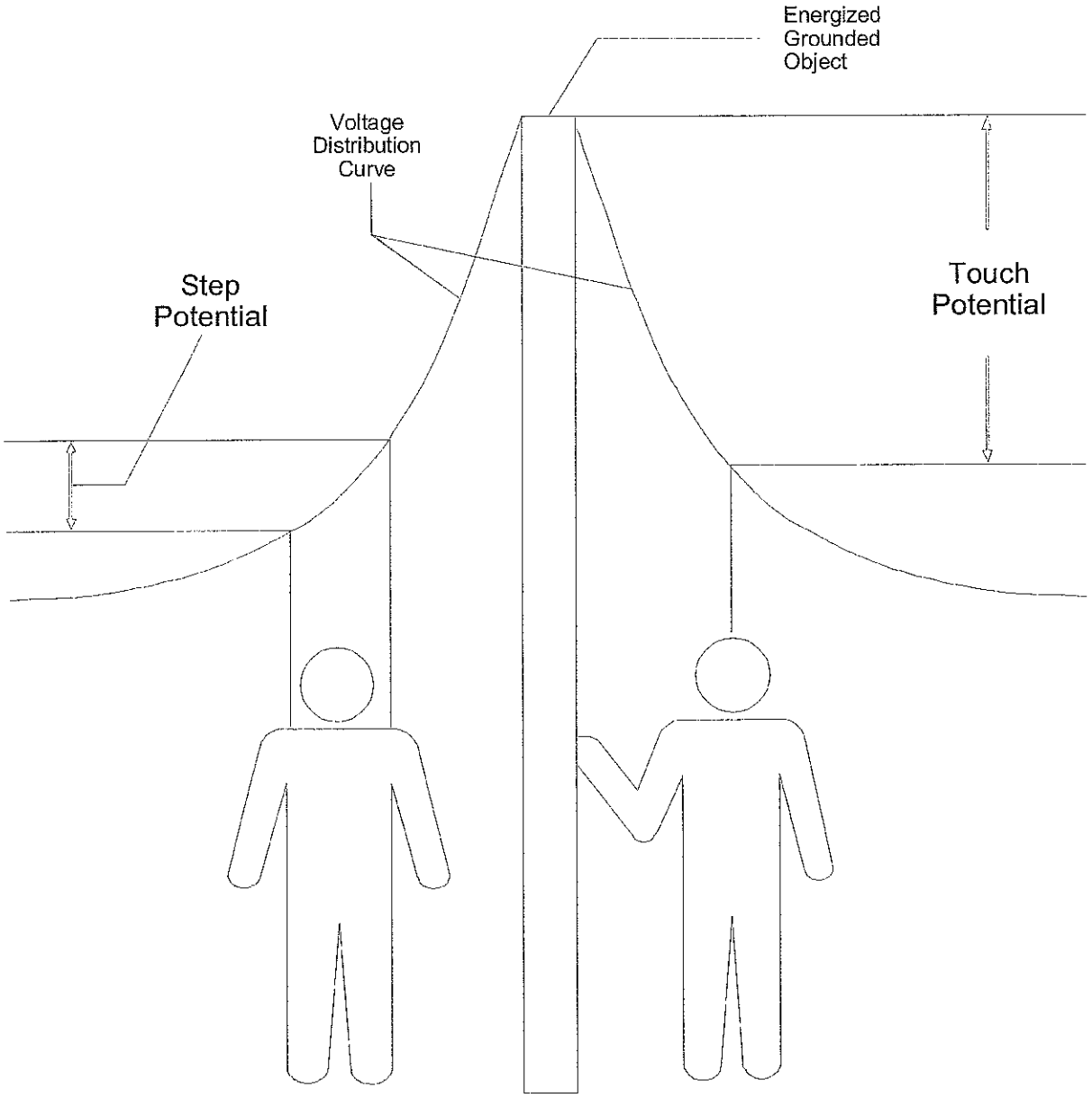

Figure 2—Step and Touch Potentials

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.

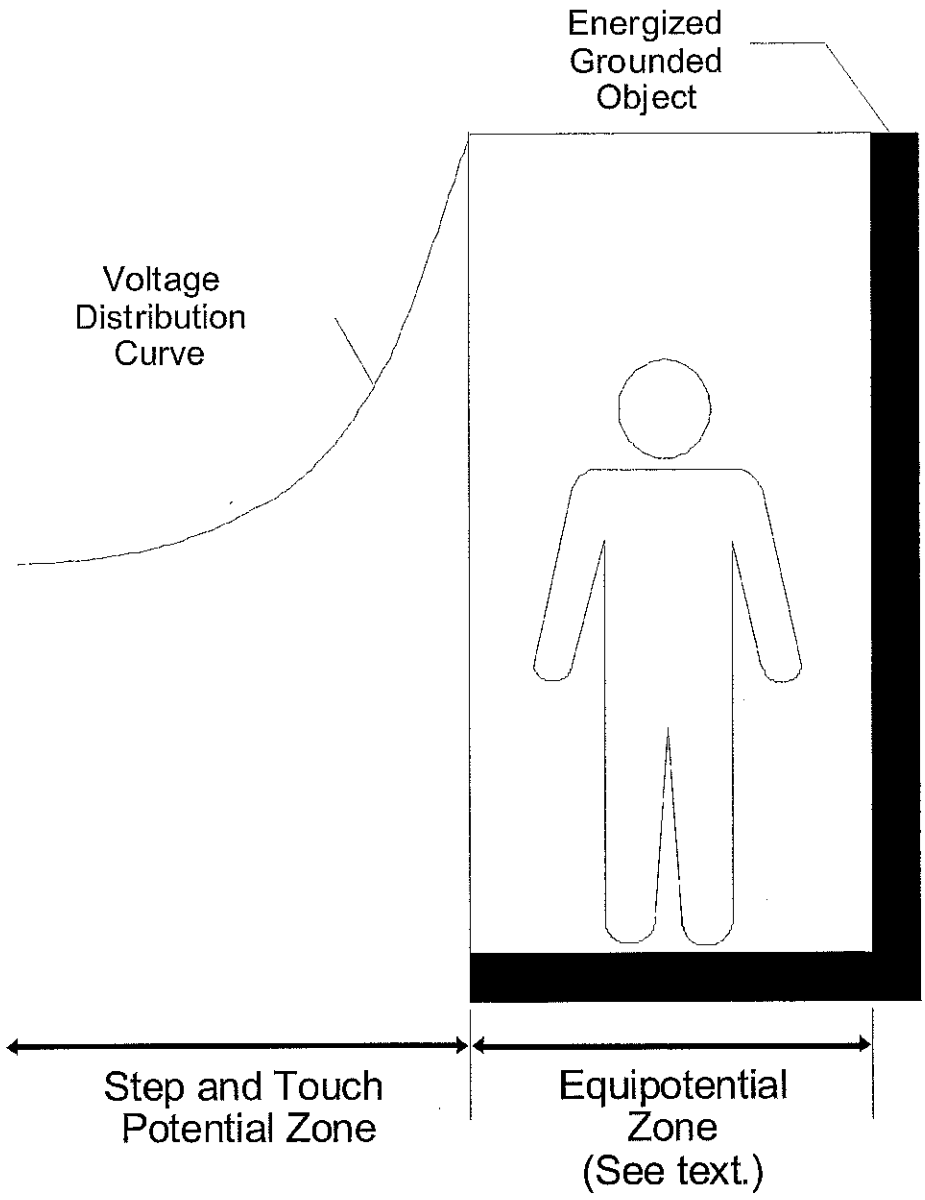

Figure 3—Protection from Ground-Potential Gradients

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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 § 1910.269(n) for using protective grounding to protect employees working on deenergized power lines. Paragraph (n) of § 1910.269 applies to grounding of transmission and distribution lines and equipment for the purpose of protecting workers. Paragraph (n)(3) of § 1910.269 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.[16] Sections III.D.1 and III.D.2 of this appendix provide guidelines that employers can use in making the demonstration required by § 1910.269(n)(3). Section III.D.1 of this appendix provides guidelines on how the employer can determine whether particular grounding practices expose employees to hazardous differences in electric potential. Section III.D.2 of this appendix describes grounding methods that the employer can use in lieu of an engineering analysis to make the demonstration required by § 1910.269(n)(3). The Occupational Safety and Health Administration will consider employers that comply with the criteria in this appendix as meeting § 1910.269(n)(3).

Finally, Section III.D.3 of this appendix discusses other safety considerations that will help the employer comply with other requirements in § 1910.269(n). Following these guidelines will protect workers from hazards that can occur when a deenergized and grounded line becomes energized.

1. *Determining safe body current limits.* This Section III.D.1 of Appendix C provides guidelines on how an employer can determine whether any differences in electric potential to which workers could be exposed are hazardous as part of the demonstration required by § 1910.269(n)(3).

[16] The protective grounding required by § 1910.269(n) 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.

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 [17]).

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 § 1910.269(n)(3) without an engineering determination of the potential differences. These methods follow two principles: (i) The grounding method must ensure that the circuit opens in the fastest available clearing time, and (ii) the grounding method must ensure that the potential differences between conductive objects in the employee's work area are as low as possible.

Paragraph (n)(3) of § 1910.269 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 § 1910.269(n)(3).

i. *Ensuring that the circuit opens in the fastest available clearing time.* Generally, the higher the fault current, the shorter the clearing times for the same type of fault. Therefore, to ensure the fastest available clearing time, the grounding method must maximize the fault current with a low impedance connection to ground. The employer accomplishes this objective by grounding the circuit conductors to the best ground available at the worksite. Thus, the employer must ground to a grounded system neutral conductor, if one is present. A grounded system neutral has a direct connection to the system ground at the source, resulting in an extremely low impedance to ground. In a substation, the employer may instead ground to the substation grid, which also has an extremely low impedance to the system ground and, typically, is connected to a grounded system neutral when one is present. Remote system grounds, such as pole and tower grounds, have a higher impedance to the system ground than grounded system neutrals and substation grounding grids; however, the employer may use a remote ground when lower impedance grounds are not available. In the absence of a grounded system neutral, substation grid, and remote ground, the employer may use a temporary driven ground at the worksite.

In addition, if employees are working on a three-phase system, the grounding method must short circuit all three phases. Short circuiting all phases will ensure faster clearing and lower the current through the grounding cable connecting the deenergized line to ground, thereby lowering the voltage across that cable. The short circuit need not be at the worksite; however, the employer must treat any conductor that is not grounded at the worksite as energized because the ungrounded conductors will be energized at fault voltage during a fault.

ii. *Ensuring that the potential differences between conductive objects in the employee's work area are as low as possible.* To achieve as low a voltage as possible across any two conductive objects in the work area, the employer must bond all conductive objects in the work area. This section of this appendix discusses how to create a zone that minimizes differences in electric potential between conductive objects in the work area.

The employer must use bonding cables to bond conductive objects, except for metallic objects bonded through metal-to-metal contact. The employer must ensure that metal-to-metal contacts are tight and free of contamination, such as oxidation, that can increase the impedance across the connection. For example, a bolted connection between metal lattice tower members is acceptable if the connection is tight and free of corrosion and other contamination. Figure 4 shows how to create an equipotential zone for metal lattice towers.

Wood poles are conductive objects. The poles can absorb moisture and conduct electricity, particularly at distribution and transmission voltages. Consequently, the employer must either: (1) Provide a conductive platform, bonded to a grounding cable, on which the worker stands or (2) use cluster bars to bond wood poles to the grounding cable. The employer must ensure that employees install the cluster bar below, and close to, the worker's feet. The inner portion of the wood pole is more conductive than the outer shell, so it is important that the cluster bar be in conductive contact with a metal spike or nail that penetrates the wood to a depth greater than or equal to the depth the worker's climbing gaffs will penetrate the wood. For example, the employer could mount the cluster bar on a bare pole ground wire fastened to the pole with nails or staples that penetrate to the required depth. Alternatively, the employer may temporarily nail a conductive strap to the pole and connect the strap to the cluster bar. Figure 5 shows how to create an equipotential zone for wood poles.

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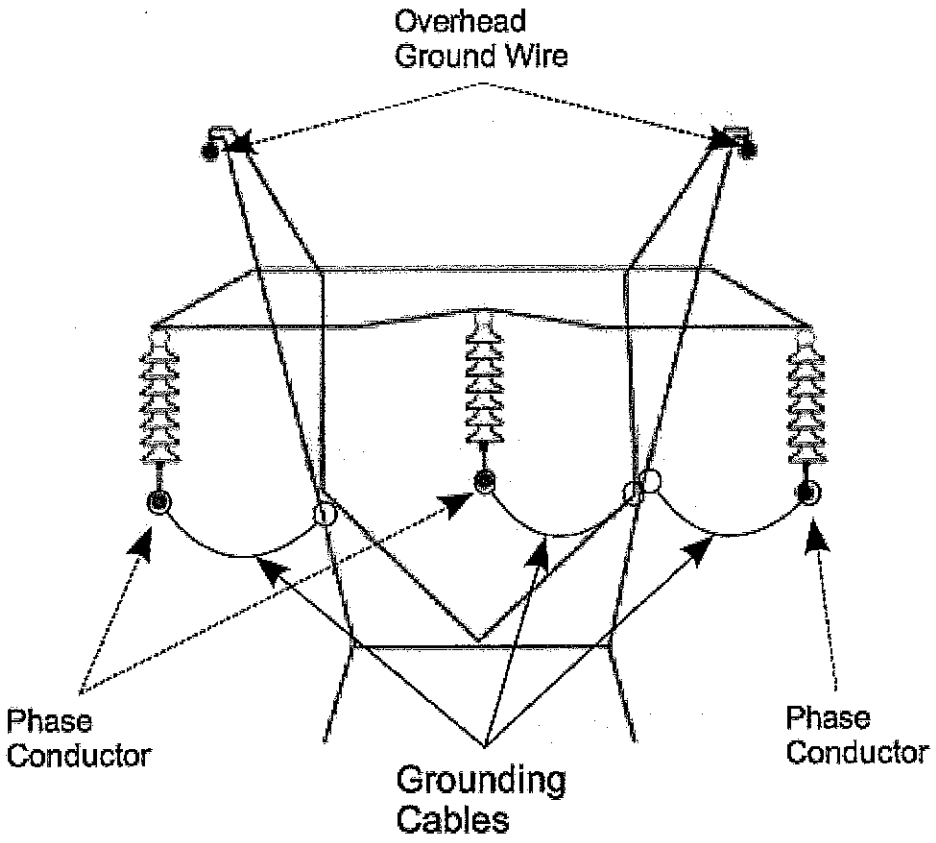
[17] Electric current passing through the body has varying effects depending on the amount of the current. At the let-go threshold, the current overrides a person's control over his or her muscles. At that level, an employee grasping an object will not be able to let go of the object. The let-go threshold varies from person to person; however, the recognized value for workers is 6 milliamperes.



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 4—Equipotential Zone for Metal Lattice Tower

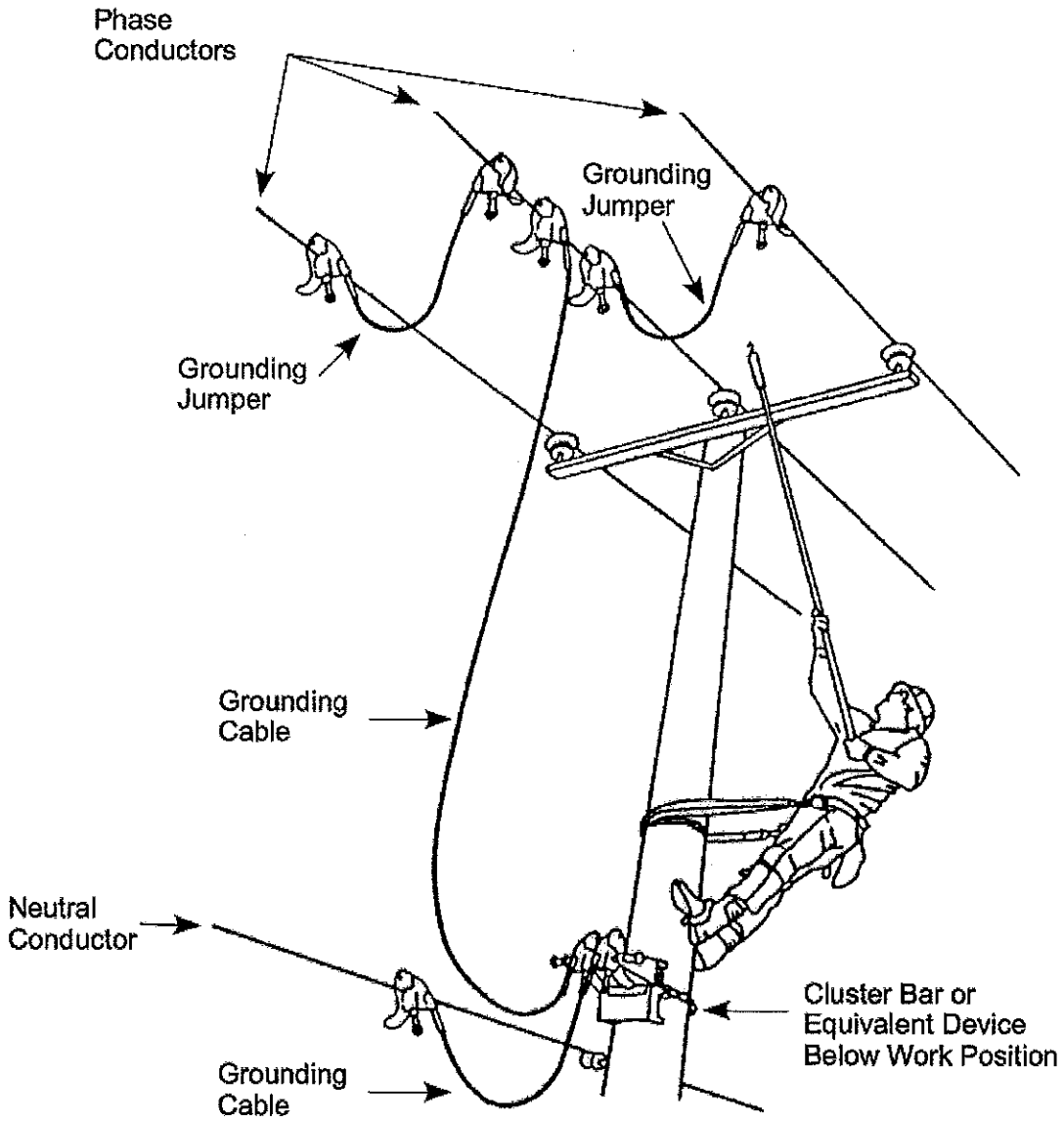


Figure 5—Equipotential Grounding for Wood Poles

Figure reprinted with permission from Hubbell Power Systems, Inc. (Hubbell).

OSHA revised the figure from Hubbell's original.

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For underground systems, employers commonly install grounds at the points of disconnection of the underground cables. These grounding points are typically remote from the manhole or underground vault where employees will be working on the cable. Workers in contact with a cable grounded at a remote location can experience hazardous potential differences if the cable becomes energized or if a fault occurs on a different, but nearby, energized cable. The fault current causes potential gradients in the earth, and a potential difference will exist between the earth where the worker is standing and the earth where the cable is grounded. Consequently, to create an equipotential zone for the worker, the employer 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: [18]

[18] 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 § 1910.269(n)(4)(i). IEEE Std 1048–2003 contains

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.

Appendix D to § 1910.269—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.[19] For these reasons, it is essential that, before an employee climbs a wood pole, the employer ascertain that the pole is capable of sustaining the stresses of the work. The determination that the pole is capable of sustaining these stresses includes an inspection of the condition of the pole.

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

II. Inspecting Wood Poles

A qualified employee should inspect wood poles for the following conditions:[20]

A. *General condition.* Buckling at the ground line or an unusual angle with respect to the ground may indicate that the pole has rotted or is broken.

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

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

D. *Shell rot and decay.* Rotting and decay are cutout hazards and possible indications of the age and internal condition of the pole.

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

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

G. *Soil conditions.* Soft, wet, or loose soil around the base of the pole may indicate that the pole will not support any change in stress.

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

III. Testing Wood Poles

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

A. *Hammer test.* Rap the pole sharply with a hammer weighing about 1.4 kg (3 pounds), starting near the ground line and continuing upwards circumferentially around the pole to a height of approximately 1.8 meters (6 feet). The hammer will produce a clear sound and rebound sharply when striking sound wood. Decay pockets will be indicated by a dull sound or a less pronounced hammer rebound. Also, prod the pole as near the ground line as possible using a pole prod or a screwdriver with a blade at least 127 millimeters (5 inches) long. If substantial decay is present, the pole is unsafe.

B. *Rocking test.* Apply a horizontal force to the pole and attempt to rock it back and forth in a direction perpendicular to the line. Exercise caution to avoid causing power lines to swing together. Apply the force to the pole either by pushing it with a pike pole or pulling the pole with a rope. If the pole cracks during the test, it is unsafe.

Appendix E to § 1910.269—Protection From Flames and Electric Arcs

I. Introduction

Paragraph (l)(8) of § 1910.269 addresses protecting employees from flames and electric arcs. This paragraph requires employers to: (1) Assess the workplace for flame and electric-arc hazards (paragraph (l)(8)(i)); (2) estimate the available heat energy from electric arcs to which employees would be exposed (paragraph (l)(8)(ii)); (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 (l)(8)(iii)); and (4) ensure that employees wear flame-resistant clothing[21] 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 (l)(8)(iv) and (l)(8)(v)). This appendix contains information to help employers estimate available heat energy as required by § 1910.269(l)(8)(ii), select protective clothing and other protective equipment with an arc rating suitable for the available heat energy as required by § 1910.269(l)(8)(v), and ensure that employees do not wear flammable clothing that could lead to burn injury as addressed by §§ 1910.269(l)(8)(iii) and (l)(8)(iv).

II. Assessing the Workplace for Flame and Electric-Arc Hazards

Paragraph (l)(8)(i) of § 1910.269 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

guidelines for selecting and installing grounding equipment that will meet § 1910.269(n)(4)(i).

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

[20] 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.

[21] 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.*)

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 § 1910.269(l)(3)(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 ASSESSMENTS FOR VARIOUS TASKS

Task		Is employee exposed to flame or electric-arc hazard?
Normal operation of enclosed equipment, such as closing or opening a switch.	The employer properly installs and maintains enclosed equipment, and there is no evidence of impending failure.	No.
	There is evidence of arcing or overheating	Yes.
	Parts of the equipment are loose or sticking, or the equipment otherwise exhibits signs of lack of maintenance.	Yes.
Servicing electric equipment, such as racking in a circuit breaker or replacing a switch		Yes.
Inspection of electric equipment with exposed 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 (l)(8)(ii) of § 1910.269 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	$MAD - (2 \times kV \times 2.54)$ ($MAD - (2 \times kV/10)$) †	NA

*NA = not applicable.
† The terms in this equation are:
MAD = The applicable minimum approach distance, and
kV = The system voltage in kilovolts.

Selecting a reasonable arc gap. For a single-phase arc in air, the electric arc will almost always occur when an energized conductor approaches too close to ground. Thus, an employer can determine the arc gap, or arc length, for these exposures by the dielectric strength of air and the voltage on the line. The dielectric strength of air is approximately 10 kilovolts for every 25.4 millimeters (1 inch). For example, at 50 kilovolts, the arc gap would be $50 \div 10 \times 25.4$ (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).

TABLE 5—SELECTING A REASONABLE ARC GAP—Continued

Class of equipment	Single-phase arc mm (inches)	Three-phase arc mm [1] (inches)
Single conductors in air, 15 kV and less	51 (2.0)	Phase conductor spacing.
Single conductor in air, more than 15 kV	Voltage in $kV \times 2.54$ (Voltage in $kV \times 0.1$), but no less than 51 mm (2 inches).	Phase conductor spacing.

[1] Source: IEEE Std 1584b–2011.
[2] NA = not applicable.

Making estimates over multiple system areas. The employer need not estimate the heat-energy exposure for every job task performed by each employee. Paragraph (l)(8)(ii) of § 1910.269 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.[22] 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.[23] 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 § 1910.269(l)(8)(v). Alternatively, an employer could select a base incident-energy value and ensure that the clearing times for each voltage range and fault current listed in the table do not exceed the corresponding clearing time specified in the table. For example, an employer that provides employees with arc-flash protective equipment rated at 8 cal/cm^2 can use the table to determine if any system area exceeds 8 cal/cm^2 by checking the clearing time for the highest fault current for each voltage range and ensuring that the clearing times do not exceed the values specified in the 8-cal/cm^2 column in the table.

Table 7 presents similar estimates for employees using live-line tools to perform work on overhead systems operating at voltages of 4 to 800 kilovolts. The table assumes that the arc length will be equal to the sparkover distance [24] and that the employee will be a distance from the arc equal to the minimum approach distance minus twice the sparkover distance.

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

TABLE 6—INCIDENT HEAT ENERGY FOR VARIOUS FAULT CURRENTS, CLEARING TIMES, AND VOLTAGES OF 4.0 TO 46.0 KV: RUBBER INSULATING GLOVE EXPOSURES INVOLVING PHASE-TO-GROUND ARCS IN OPEN AIR ONLY *†‡

Voltage range (kV) **	Fault current (kA)	Maximum clearing time (cycles)			
		4 cal/cm^2	5 cal/cm^2	8 cal/cm^2	12 cal/cm^2
4.0 to 15.0	5	46	58	92	138
	10	18	22	36	54
	15	10	12	20	30
	20	6	8	13	19
15.1 to 25.0	5	28	34	55	83
	10	11	14	23	34
	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

[22] 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.

[23] 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.

[24] The dielectric strength of air is about 10 kilovolts for every 25.4 millimeters (1 inch). Thus, the employer can estimate the arc length in millimeters to be the phase-to-ground voltage in kilovolts multiplied by 2.54 (or voltage (in kilovolts) × 2.54).

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*†‡—Continued

Voltage range (kV)**	Fault current (kA)	Maximum clearing time (cycles)			
		4 cal/cm²	5 cal/cm²	8 cal/cm²	12 cal/cm²
	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 §1910.269), 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/cm²	5 cal/cm²	8 cal/cm²	12 cal/cm²
4.0 to 15.0	5	197	246	394	591
	10	73	92	147	220
	15	39	49	78	117
	20	24	31	49	73
15.1 to 25.0	5	197	246	394	591
	10	75	94	150	225
	15	41	51	82	122
	20	26	33	52	78
25.1 to 36.0	5	138	172	275	413
	10	53	66	106	159
	15	30	37	59	89
	20	19	24	38	58
36.1 to 46.0	5	129	161	257	386
	10	51	64	102	154
	15	29	36	58	87
	20	19	24	38	57
46.1 to 72.5	20	18	23	36	55
	30	10	13	20	30
	40	6	8	13	19
	50	4	6	9	13
72.6 to 121.0	20	10	12	20	30
	30	6	7	11	17
	40	4	5	7	11
	50	3	3	5	8
121.1 to 145.0	20	12	15	24	35
	30	7	9	15	22
	40	5	6	10	15
	50	4	5	8	11
145.1 to 169.0	20	12	15	24	36
	30	7	9	15	22
	40	5	7	10	16
	50	4	5	8	12
169.1 to 242.0	20	13	17	27	40
	30	8	10	17	25
	40	6	7	12	17
	50	4	5	9	13
242.1 to 362.0	20	25	32	51	76
	30	16	19	31	47
	40	11	14	22	33
	50	8	10	16	25
362.1 to 420.0	20	12	15	25	37
	30	8	10	15	23
	40	5	7	11	16
	50	4	5	8	12
420.1 to 550.0	20	23	29	47	70
	30	14	18	29	43
	40	10	13	20	30
	50	8	9	15	23
550.1 to 800.0	20	25	31	50	75
	30	15	19	31	46
	40	11	13	21	32

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* † ‡ #—Continued

Voltage range (kV) **	Fault current (kA)	Maximum clearing time (cycles)			
		4 cal/cm²	5 cal/cm²	8 cal/cm²	12 cal/cm²
	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 section). The table also assumes that the employee will be the minimum approach distance minus twice the arc length from the electric arc.

‡The Occupational Safety and Health Administration calculated the values in this table using the ARCPRO method listed in Table 2.

#For voltages of more than 72.6 kV, employers may use this table only when the minimum approach distance established under § 1910.269(l)(3)(i) is greater than or equal to the following values:

72.6 to 121.0 kV 1.02 m.
121.1 to 145.0 kV 1.16 m.
145.1 to 169.0 kV 1.30 m.
169.1 to 242.0 kV 1.72 m.
242.1 to 362.0 kV 2.76 m.
362.1 to 420.0 kV 2.50 m.
420.1 to 550.0 kV 3.62 m.
550.1 to 800.0 kV 4.83 m.

**The voltage range is the phase-to-phase system voltage.

B. Selecting Protective Clothing and Other Protective Equipment

Paragraph (l)(8)(v) of § 1910.269 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 § 1910.269(l)(8)(ii). 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 [25] (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 § 1910.269(l)(8)(v) 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 § 1910.269(l)(8)(v) will provide an appropriate degree of protection for an employee exposed to electric-arc hazards.

Paragraph (l)(8)(v) of § 1910.269 does not require arc-rated protection for exposures of 2 cal/cm² or less. Untreated cotton clothing will reduce a 2-cal/cm² exposure below the 1.2- to 1.5-cal/cm² level necessary to cause burn injury, and this material should not ignite at such low heat energy levels. Although § 1910.269(l)(8)(v) does not require clothing to have an arc rating when exposures are 2 cal/cm² or less, § 1910.269(l)(8)(iv) requires the outer layer of clothing to be flame resistant under certain conditions, even when the estimated incident heat energy is less than 2 cal/cm², as discussed later in this appendix. Additionally, it is especially important to ensure that employees do not wear undergarments made from fabrics listed in the note to § 1910.269(l)(8)(iii) 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 § 1910.269(l)(8)(iii), (l)(8)(iv), or (l)(8)(v).

Paragraph (l)(8)(v) of § 1910.269 requires that arc-rated protection cover the employee's entire body, with limited exceptions for the employee's hands, feet, face, and head. Paragraph (l)(8)(v)(A) of § 1910.269 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/cm²	When the employee is wearing heavy-duty leather work gloves with a weight of at least 407 gm/m² (12 oz/yd²).

Paragraph (l)(8)(v)(B) of § 1910.269 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, § 1910.269(l)(8)(v)(C), (l)(8)(v)(D), and (l)(8)(v)(E) require arc-rated head and face protection as follows:

Exposure	Minimum head and face protection		
	None*	Arc-rated faceshield with a minimum rating of 8 cal/cm²*	Arc-rated hood or faceshield with balaclava
Single-phase, open air	2–8 cal/cm²	9–12 cal/cm²	13 cal/cm² or higher†.

[25] ASTM F1506–10a defines "arc thermal performance value" as "the incident energy on a material or a multilayer system of materials that results in a 50% probability that sufficient heat transfer through the tested specimen is predicted to cause the onset of a second-degree skin burn injury based on the Stoll [footnote] curve, cal/cm²." The footnote to this definition reads: "Derived from: Stoll, A. M., and Chianta, M. A., 'Method and Rating System for Evaluations of Thermal Protection,' Aerospace Medicine, Vol 40, 1969, pp. 1232–1238 and Stoll, A. M., and Chianta, M. A., 'Heat Transfer through Fabrics as Related to Thermal Injury,' Transactions—New York Academy of Sciences, Vol 33(7), Nov. 1971, pp. 649–670."

Exposure	Minimum head and face protection		
	None*	Arc-rated faceshield with a minimum rating of 8 cal/cm² *	Arc-rated hood or faceshield with balaclava
Three-phase	2–4 cal/cm²	5–8 cal/cm²	9 cal/cm² 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/cm² less than the estimated incident energy. Note that § 1910.269(l)(8)(v)(E) permits this type of head and face protection, with a minimum arc rating of 4 cal/cm² less than the estimated incident energy, at any incident energy level.
‡Note that § 1910.269(l)(8)(v) permits this type of head and face protection at any incident energy level.

IV. Protection Against Ignition

Paragraph (l)(8)(iii) of § 1910.269 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 § 1910.269(l)(8)(ii). 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 (l)(8)(v) of § 1910.269 generally requires protective clothing and other protective equipment with an arc rating greater than or equal to the employer's estimate of available heat energy. As explained earlier in this appendix, untreated cotton is usually acceptable for exposures of 2 cal/cm² or less.[26] If the exposure is greater than that, the employee generally must wear flame-resistant clothing with a suitable arc rating in accordance with § 1910.269(l)(8)(iv) and (l)(8)(v). 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 § 1910.269(l)(8)(iii), it is important for the employer to consider the possibility of clothing ignition even when an employee is wearing flame-resistant clothing with a suitable arc rating.

Under § 1910.269(l)(8)(iii), employees may not wear flammable clothing in conjunction with flame-resistant clothing if the flammable clothing poses an ignition hazard.[27] 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,[28] the next (inner) layer must be flame-resistant if it could ignite.

Non-flame-resistant clothing can ignite even when the heat energy from an electric arc is insufficient to ignite the clothing. For example, nearby flames can ignite an employee's clothing; and, even in the absence of flames, electric arcs pose ignition hazards beyond the hazard of ignition from incident energy under certain conditions. In addition to requiring flame-resistant clothing when the estimated incident energy exceeds 2.0 cal/cm², § 1910.269(l)(8)(iv) requires flame-resistant clothing when: The employee is exposed to contact with energized circuit parts operating at more than 600 volts (§ 1910.269(l)(8)(iv)(A)), an electric arc could ignite flammable material in the work area that, in turn, could ignite the employee's clothing (§ 1910.269(l)(8)(iv)(B)), and molten metal or electric arcs from faulted conductors in the work area could ignite the employee's clothing (§ 1910.269(l)(8)(iv)(C)). For example, grounding conductors can become a source of heat energy if they cannot carry fault current without failure. The employer must consider these possible sources of electric arcs[29] in determining whether the employee's clothing could ignite under § 1910.269(l)(8)(iv)(C).

Appendix F to § 1910.269—Work-Positioning Equipment Inspection Guidelines

I. Body Belts

Inspect body belts to ensure that:

A. The hardware has no cracks, nicks, distortion, or corrosion;

B. No loose or worn rivets are present;

C. The waist strap has no loose grommets;

D. The fastening straps are not 100-percent leather; and

E. No worn materials that could affect the safety of the user are present.

II. Positioning Straps

Inspect positioning straps to ensure that:

A. The warning center of the strap material is not exposed;

B. No cuts, burns, extra holes, or fraying of strap material is present;

C. Rivets are properly secured;

D. Straps are not 100-percent leather; and

E. Snaphooks do not have cracks, burns, or corrosion.

III. Climbers

Inspect pole and tree climbers to ensure that:

A. Gaffs are at least as long as the manufacturer's recommended minimums (generally 32 and 51 millimeters (1.25 and 2.0 inches) for pole and tree climbers, respectively, measured on the underside of the gaff);

Note: Gauges are available to assist in determining whether gaffs are long enough and shaped to easily penetrate poles or trees.

B. Gaffs and leg irons are not fractured or cracked;

C. Stirrups and leg irons are free of excessive wear;

D. Gaffs are not loose;

E. Gaffs are free of deformation that could adversely affect use;

F. Gaffs are properly sharpened; and

G. There are no broken straps or buckles.

Appendix G to § 1910.269—Reference Documents

The references contained in this appendix provide information that can be helpful in understanding and complying with the requirements contained in § 1910.269. The national consensus standards referenced in this appendix contain detailed specifications that employers may follow in complying with the more performance-based requirements of § 1910.269. Except as specifically noted in § 1910.269, however, the Occupational Safety and Health Administration will not necessarily deem compliance with the national consensus standards to be compliance with the provisions of § 1910.269.

ANSI/SIA A92.2–2009, *American National Standard for Vehicle-Mounted Elevating and Rotating Aerial Devices.*

ANSI Z133–2012, *American National Standard Safety Requirements for Arboricultural Operations—Pruning, Trimming, Repairing, Maintaining, and Removing Trees, and Cutting Brush.*

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

ASME B20.1–2012, *Safety Standard for Conveyors and Related Equipment.*

ASTM D120–09, *Standard Specification for Rubber Insulating Gloves.*

ASTM D149–09 (2013), *Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies.*

ASTM D178–01 (2010), *Standard Specification for Rubber Insulating Matting.*

ASTM D1048–12, *Standard Specification for Rubber Insulating Blankets.*

[26] See § 1910.269(l)(8)(iv)(A), (l)(8)(iv)(B), and (l)(8)(iv)(C) for conditions under which employees must wear flame-resistant clothing as the outer layer of clothing even when the incident heat energy does not exceed 2 cal/cm².

[27] Paragraph (l)(8)(iii) of § 1910.269 prohibits clothing that could ignite and continue to burn when exposed to the heat energy estimated under paragraph (l)(8)(ii) of that section.

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

[29] 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.

ASTM D1049–98 (2010), *Standard Specification for Rubber Insulating Covers.*
ASTM D1050–05 (2011), *Standard Specification for Rubber Insulating Line Hose.*
ASTM D1051–08, *Standard Specification for Rubber Insulating Sleeves.*
ASTM F478–09, *Standard Specification for In-Service Care of Insulating Line Hose and Covers.*
ASTM F479–06 (2011), *Standard Specification for In-Service Care of Insulating Blankets.*
ASTM F496–08, *Standard Specification for In-Service Care of Insulating Gloves and Sleeves.*
ASTM F711–02 (2007), *Standard Specification for Fiberglass-Reinforced Plastic (FRP) Rod and Tube Used in Live Line Tools.*
ASTM F712–06 (2011), *Standard Test Methods and Specifications for Electrically Insulating Plastic Guard Equipment for Protection of Workers.*
ASTM F819–10, *Standard Terminology Relating to Electrical Protective Equipment for Workers.*
ASTM F855–09, *Standard Specifications for Temporary Protective Grounds to Be Used on De-energized Electric Power Lines and Equipment.*
ASTM F887–12^{e1}, *Standard Specifications for Personal Climbing Equipment.*
ASTM F914/F914M–10, *Standard Test Method for Acoustic Emission for Aerial Personnel Devices Without Supplemental Load Handling Attachments.*
ASTM F1116–03 (2008), *Standard Test Method for Determining Dielectric Strength of Dielectric Footwear.*
ASTM F1117–03 (2008), *Standard Specification for Dielectric Footwear.*
ASTM F1236–96 (2012), *Standard Guide for Visual Inspection of Electrical Protective Rubber Products.*
ASTM F1430/F1430M–10, *Standard Test Method for Acoustic Emission Testing of Insulated and Non-Insulated Aerial Personnel Devices with Supplemental Load Handling Attachments.*
ASTM F1505–10, *Standard Specification for Insulated and Insulating Hand Tools.*
ASTM F1506–10a, *Standard Performance Specification for Flame Resistant and Arc Rated Textile Materials for Wearing Apparel for Use by Electrical Workers Exposed to Momentary Electric Arc and Related Thermal Hazards.*
ASTM F1564–13, *Standard Specification for Structure-Mounted Insulating Work Platforms for Electrical Workers.*
ASTM F1701–12, *Standard Specification for Unused Polypropylene Rope with Special Electrical Properties.*
ASTM F1742–03 (2011), *Standard Specification for PVC Insulating Sheeting.*
ASTM F1796–09, *Standard Specification for High Voltage Detectors—Part 1 Capacitive Type to be Used for Voltages Exceeding 600 Volts AC.*
ASTM F1797–09^{e1}, *Standard Test Method for Acoustic Emission Testing of Insulated and Non-Insulated Digger Derricks.*
ASTM F1825–03 (2007), *Standard Specification for Clampstick Type Live Line Tools.*
ASTM F1826–00 (2011), *Standard Specification for Live Line and Measuring Telescoping Tools.*
ASTM F1891–12, *Standard Specification for Arc and Flame Resistant Rainwear.*
ASTM F1958/F1958M–12, *Standard Test Method for Determining the Ignitability of Non-flame-Resistant Materials for Clothing by Electric Arc Exposure Method Using Mannequins.*
ASTM F1959/F1959M–12, *Standard Test Method for Determining the Arc Rating of Materials for Clothing.*
IEEE Stds 4–1995, 4a-2001 (Amendment to *IEEE Standard Techniques for High-Voltage Testing*), *IEEE Standard Techniques for High-Voltage Testing.*
IEEE Std 62–1995, *IEEE Guide for Diagnostic Field Testing of Electric Power Apparatus—Part 1: Oil Filled Power Transformers, Regulators, and Reactors.*
IEEE Std 80–2000, *Guide for Safety in AC Substation Grounding.*
IEEE Std 100–2000, *The Authoritative Dictionary of IEEE Standards Terms Seventh Edition.*
IEEE Std 516–2009, *IEEE Guide for Maintenance Methods on Energized Power Lines.*
IEEE Std 524–2003, *IEEE Guide to the Installation of Overhead Transmission Line Conductors .*
IEEE Std 957–2005, *IEEE Guide for Cleaning Insulators.*
IEEE Std 1048–2003, *IEEE Guide for Protective Grounding of Power Lines.*
IEEE Std 1067–2005, *IEEE Guide for In-Service Use, Care, Maintenance, and Testing of Conductive Clothing for Use on Voltages up to 765 kV AC and ±750 kV DC.*
IEEE Std 1307–2004, *IEEE Standard for Fall Protection for Utility Work.*
IEEE Stds 1584–2002, 1584a-2004 (Amendment 1 to IEEE Std 1584–2002), and 1584b-2011 (Amendment 2: Changes to Clause 4 of IEEE Std 1584–2002), *IEEE Guide for Performing Arc-Flash Hazard Calculations.*
IEEE C2–2012, *National Electrical Safety Code.*
NFPA 70E–2012, *Standard for Electrical Safety in the Workplace.*

Subpart S—Electrical

■ 7. Revise the authority citation for Subpart S of part 1910 to read as follows:

Authority: 29 U.S.C. 653, 655, 657; Secretary of Labor's Order No. 8–76 (41 FR 25059), 1–90 (55 FR 9033), 5–2002 (67 FR 65008), 5–2007 (72 FR 31160), or 1–2012 (77 FR 3912), as applicable; and 29 CFR Part 1911.

■ 8. In § 1910.331(c)(1), revise the headings to Notes 1 and 2 and revise Note 3 to read as follows:

§ 1910.331 Scope.

* * * * *

(c) * * *

(1) * * *

Note 1 to paragraph (c)(1): * * *

Note 2 to paragraph (c)(1): * * *

Note 3 to paragraph (c)(1): Work on or directly associated with generation, transmission, or distribution installations includes:

(1) Work performed directly on such installations, such as repairing overhead or underground distribution lines or repairing a feed-water pump for the boiler in a generating plant.

(2) Work directly associated with such installations, such as line-clearance tree trimming and replacing utility poles (see the definition of "line-clearance tree trimming" in § 1910.269(x)).

(3) Work on electric utilization circuits in a generating plant provided that:

(A) Such circuits are commingled with installations of power generation equipment or circuits, and

(B) The generation equipment or circuits present greater electrical hazards than those posed by the utilization equipment or circuits (such as exposure to higher voltages or lack of overcurrent protection).

This work is covered by § 1910.269 of this part.

§ 1910.399 [Amended]

■ 9. Remove the definition of "line-clearance tree trimming" from § 1910.399.

PART 1926—[AMENDED]

Subpart A—General

■ 10. The authority citation for Subpart A of part 1926 is revised to read as follows:

Authority: 40 U.S.C. 3701 *et seq.*; 29 U.S.C. 653, 655, 657; Secretary of Labor's Order No. 12–71 (36 FR 8754), 8–76 (41 FR 25059), 9–83 (48 FR 35736), 1–90 (55 FR 9033), 6–96 (62 FR 111), 3–2000 (65 FR 50017), 5–2002 (67 FR 65008), or 5–2007 (72 FR 31160), 5–2007 (72 FR 31160), 4–2010 (75 FR 55355), or 1–2012 (77 FR 3912), as applicable; and 29 CFR Part 1911.

■ 11. In § 1926.6, remove and reserve paragraphs (h)(17), (h)(18), (h)(19), (h)(20), (h)(21), (h)(22), and (j)(2).

§ 1926.6 Incorporation by reference.

* * * * *

(h) * * *

(17) [Reserved]
(18) [Reserved]
(19) [Reserved]
(20) [Reserved]
(21) [Reserved]
(22) [Reserved]

* * * * *

(j) * * *

(2) [Reserved]

* * * * *

Subpart E—Personal Protective and Life Saving Equipment

■ 12. Revise the authority citation for Subpart E of Part 1926 to read as follows:

Authority: 40 U.S.C. 3701 *et seq.*; 29 U.S.C. 653, 655, 657; Secretary of Labor's Order No. 12–71 (36 FR 8754), 8–76 (41 FR 25059), 9–83 (48 FR 35736), 1–90 (55 FR 9033), 6–96 (62 FR 111), 5–2002 (67 FR 65008), 5–2007 (72 FR 31160), or 1–2012 (77 FR 3912), as applicable; and 29 CFR Part 1911.

■ 13. Add § 1926.97 to read as follows:

§ 1926.97 Electrical protective equipment.

(a) *Design requirements for specific types of electrical protective equipment.* Rubber insulating blankets, rubber insulating matting, rubber insulating covers, rubber insulating line hose, rubber insulating gloves, and rubber insulating sleeves shall meet the following requirements:

(1) *Manufacture and marking of rubber insulating equipment.* (i) Blankets, gloves, and sleeves shall be produced by a seamless process.

(ii) Each item shall be clearly marked as follows:

(A) Class 00 equipment shall be marked Class 00.

(B) Class 0 equipment shall be marked Class 0.

(C) Class 1 equipment shall be marked Class 1.

(D) Class 2 equipment shall be marked Class 2.

(E) Class 3 equipment shall be marked Class 3.

(F) Class 4 equipment shall be marked Class 4.

(G) Nonozone-resistant equipment shall be marked Type I.

(H) Ozone-resistant equipment shall be marked Type II.

(I) Other relevant markings, such as the manufacturer's identification and the size of the equipment, may also be provided.

(iii) Markings shall be nonconducting and shall be applied in such a manner as not to impair the insulating qualities of the equipment.

(iv) Markings on gloves shall be confined to the cuff portion of the glove.

(2) *Electrical requirements.* (i) Equipment shall be capable of withstanding the ac proof-test voltage specified in Table E–1 or the dc proof-test voltage specified in Table E–2.

(A) The proof test shall reliably indicate that the equipment can withstand the voltage involved.

(B) The test voltage shall be applied continuously for 3 minutes for equipment other than matting and shall be applied continuously for 1 minute for matting.

(C) Gloves shall also be capable of separately withstanding the ac proof-test voltage specified in Table E–1 after a 16-hour water soak. (See the note following paragraph (a)(3)(ii)(B) of this section.)

(ii) When the ac proof test is used on gloves, the 60-hertz proof-test current may not exceed the values specified in Table E–1 at any time during the test period.

(A) If the ac proof test is made at a frequency other than 60 hertz, the permissible proof-test current shall be computed from the direct ratio of the frequencies.

(B) For the test, gloves (right side out) shall be filled with tap water and immersed in water to a depth that is in accordance with Table E–3. Water shall be added to or removed from the glove, as necessary, so that the water level is the same inside and outside the glove.

(C) After the 16-hour water soak specified in paragraph (a)(2)(i)(C) of this section, the 60-hertz proof-test current may not exceed the values given in Table E–1 by more than 2 milliamperes.

(iii) Equipment that has been subjected to a minimum breakdown voltage test may not be used for electrical protection. (See the note following paragraph (a)(3)(ii)(B) of this section.)

(iv) Material used for Type II insulating equipment shall be capable of withstanding an ozone test, with no visible effects. The ozone test shall reliably indicate that the material will resist ozone exposure in actual use. Any visible signs of ozone deterioration of the material, such as checking, cracking, breaks, or pitting, is evidence of failure to meet the requirements for ozone-resistant material. (See the note following paragraph (a)(3)(ii)(B) of this section.)

(3) *Workmanship and finish.* (i) Equipment shall be free of physical irregularities that can adversely affect the insulating properties of the equipment and that can be detected by the tests or inspections required under this section.

(ii) Surface irregularities that may be present on all rubber goods (because of imperfections on forms or molds or because of inherent difficulties in the manufacturing process) and that may appear as indentations, protuberances, or imbedded foreign material are acceptable under the following conditions:

(A) The indentation or protuberance blends into a smooth slope when the material is stretched.

(B) Foreign material remains in place when the insulating material is folded and stretches with the insulating material surrounding it.

Note to paragraph (a): Rubber insulating equipment meeting the following national consensus standards is deemed to be in compliance with the performance requirements of paragraph (a) of this section:

American Society for Testing and Materials (ASTM) D120–09, *Standard Specification for Rubber Insulating Gloves.*

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.*

The preceding standards also contain specifications for conducting the various tests required in paragraph (a) of this section. For example, the ac and dc proof tests, the breakdown test, the water-soak procedure, and the ozone test mentioned in this paragraph are described in detail in these ASTM standards.

ASTM F1236–96 (2012), *Standard Guide for Visual Inspection of Electrical Protective Rubber Products,* presents methods and techniques for the visual inspection of electrical protective equipment made of rubber. This guide also contains descriptions and photographs of irregularities that can be found in this equipment.

ASTM F819–10, *Standard Terminology Relating to Electrical Protective Equipment for Workers,* includes definitions of terms relating to the electrical protective equipment covered under this section.

(b) *Design requirements for other types of electrical protective equipment.* The following requirements apply to the design and manufacture of electrical protective equipment that is not covered by paragraph (a) of this section:

(1) *Voltage withstand.* Insulating equipment used for the protection of employees shall be capable of withstanding, without failure, the voltages that may be imposed upon it.

Note to paragraph (b)(1): These voltages include transient overvoltages, such as switching surges, as well as nominal line voltage. See Appendix B to Subpart V of this part for a discussion of transient overvoltages on electric power transmission and distribution systems. See IEEE Std 516–2009, *IEEE Guide for Maintenance Methods on Energized Power Lines,* for methods of determining the magnitude of transient overvoltages on an electrical system and for a discussion comparing the ability of insulation equipment to withstand a transient overvoltage based on its ability to withstand ac voltage testing.

(2) *Equipment current.* (i) Protective equipment used for the primary insulation of employees from energized

circuit parts shall be capable of passing a current test when subjected to the highest nominal voltage on which the equipment is to be used.

(ii) When insulating equipment is tested in accordance with paragraph (b)(2)(i) of this section, the equipment current may not exceed 1 microampere per kilovolt of phase-to-phase applied voltage.

Note 1 to paragraph (b)(2): This paragraph applies to equipment that provides primary insulation of employees from energized parts. It does not apply to equipment used for secondary insulation or equipment used for brush contact only.

Note 2 to paragraph (b)(2): For ac excitation, this current consists of three components: Capacitive current because of the dielectric properties of the insulating material itself, conduction current through the volume of the insulating equipment, and leakage current along the surface of the tool or equipment. The conduction current is normally negligible. For clean, dry insulating equipment, the leakage current is small, and the capacitive current predominates.

Note to paragraph (b): Plastic guard equipment is deemed to conform to the performance requirements of paragraph (b) of this section if it meets, and is used in accordance with, ASTM F712–06 (2011), *Standard Test Methods and Specifications for Electrically Insulating Plastic Guard Equipment for Protection of Workers.*

(c) *In-service care and use of electrical protective equipment.* (1) *General.* Electrical protective equipment shall be maintained in a safe, reliable condition.

(2) *Specific requirements.* The following specific requirements apply to rubber insulating blankets, rubber insulating covers, rubber insulating line hose, rubber insulating gloves, and rubber insulating sleeves:

(i) Maximum use voltages shall conform to those listed in Table E–4.

(ii) Insulating equipment shall be inspected for damage before each day's use and immediately following any incident that can reasonably be suspected of causing damage. Insulating gloves shall be given an air test, along with the inspection.

Note to paragraph (c)(2)(ii): ASTM F1236–96 (2012), *Standard Guide for Visual Inspection of Electrical Protective Rubber Products,* presents methods and techniques for the visual inspection of electrical protective equipment made of rubber. This guide also contains descriptions and photographs of irregularities that can be found in this equipment.

(iii) Insulating equipment with any of the following defects may not be used:

(A) A hole, tear, puncture, or cut;

(B) Ozone cutting or ozone checking (that is, a series of interlacing cracks produced by ozone on rubber under mechanical stress);

(C) An embedded foreign object;

(D) Any of the following texture changes: Swelling, softening, hardening, or becoming sticky or inelastic.

(E) Any other defect that damages the insulating properties.

(iv) Insulating equipment found to have other defects that might affect its insulating properties shall be removed from service and returned for testing under paragraphs (c)(2)(viii) and (c)(2)(ix) of this section.

(v) Insulating equipment shall be cleaned as needed to remove foreign substances.

(vi) Insulating equipment shall be stored in such a location and in such a manner as to protect it from light, temperature extremes, excessive humidity, ozone, and other damaging substances and conditions.

(vii) Protector gloves shall be worn over insulating gloves, except as follows:

(A) Protector gloves need not be used with Class 0 gloves, under limited-use conditions, when small equipment and parts manipulation necessitate unusually high finger dexterity.

Note to paragraph (c)(2)(vii)(A): Persons inspecting rubber insulating gloves used under these conditions need to take extra care in visually examining them. Employees using rubber insulating gloves under these conditions need to take extra care to avoid handling sharp objects.

(B) If the voltage does not exceed 250 volts, ac, or 375 volts, dc, protector gloves need not be used with Class 00 gloves, under limited-use conditions, when small equipment and parts manipulation necessitate unusually high finger dexterity.

Note to paragraph (c)(2)(vii)(B): Persons inspecting rubber insulating gloves used under these conditions need to take extra care in visually examining them. Employees using rubber insulating gloves under these conditions need to take extra care to avoid handling sharp objects.

(C) Any other class of glove may be used without protector gloves, under limited-use conditions, when small equipment and parts manipulation necessitate unusually high finger dexterity but only if the employer can demonstrate that the possibility of physical damage to the gloves is small and if the class of glove is one class higher than that required for the voltage involved.

(D) Insulating gloves that have been used without protector gloves may not be reused until they have been tested under the provisions of paragraphs (c)(2)(viii) and (c)(2)(ix) of this section.

(viii) Electrical protective equipment shall be subjected to periodic electrical tests. Test voltages and the maximum intervals between tests shall be in accordance with Table E–4 and Table E–5.

(ix) The test method used under paragraphs (c)(2)(viii) and (c)(2)(xi) of this section shall reliably indicate whether the insulating equipment can withstand the voltages involved.

Note to paragraph (c)(2)(ix): Standard electrical test methods considered as meeting this paragraph are given in the following national consensus standards:

ASTM D120–09, *Standard Specification for Rubber Insulating Gloves.*

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.*

(x) Insulating equipment failing to pass inspections or electrical tests may not be used by employees, except as follows:

(A) Rubber insulating line hose may be used in shorter lengths with the defective portion cut off.

(B) Rubber insulating blankets may be salvaged by severing the defective area from the undamaged portion of the blanket. The resulting undamaged area may not be smaller than 560 millimeters by 560 millimeters (22 inches by 22 inches) for Class 1, 2, 3, and 4 blankets.

(C) Rubber insulating blankets may be repaired using a compatible patch that results in physical and electrical properties equal to those of the blanket.

(D) Rubber insulating gloves and sleeves with minor physical defects, such as small cuts, tears, or punctures, may be repaired by the application of a compatible patch. Also, rubber insulating gloves and sleeves with minor surface blemishes may be repaired with a compatible liquid compound. The repaired area shall have electrical and physical properties equal to those of the surrounding material. Repairs to gloves are permitted only in the area between the wrist and the reinforced edge of the opening.

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

(xii) The employer shall certify that equipment has been tested in accordance with the requirements of paragraphs (c)(2)(iv), (c)(2)(vii)(D), (c)(2)(viii), (c)(2)(ix), and (c)(2)(xi) of this section. The certification shall identify the equipment that passed the test and the date it was tested and shall be made available upon request to the Assistant Secretary for Occupational Safety and Health and to employees or their authorized representatives.

Note to paragraph (c)(2)(xii): Marking equipment with, and entering onto logs, the results of the tests and the dates of testing are two acceptable means of meeting the certification requirement.

TABLE E–1—AC PROOF-TEST REQUIREMENTS

Class of equipment	Proof-test voltage rms V	Maximum proof-test current, mA (gloves only)			
		280-mm (11-in) glove	360-mm (14-in) glove	410-mm (16-in) glove	460-mm (18-in) glove
00	2,500	8	12	.....	.....
0	5,000	8	12	14	16
1	10,000	.....	14	16	18
2	20,000	.....	16	18	20
3	30,000	.....	18	20	22
4	40,000	.....	.....	22	24

TABLE E–2—DC PROOF-TEST REQUIREMENTS

Class of equipment	Proof-test voltage
00	10,000
0	20,000
1	40,000
2	50,000
3	60,000
4	70,000

Note: The dc voltages listed in this table are not appropriate for proof testing rubber insulating line hose or covers. For this equipment, dc proof tests shall use a voltage high enough to indicate that the equipment can be safely used at the voltages listed in Table E–4. See ASTM D1050–05 (2011) and ASTM D1049–98 (2010) for further information on proof tests for rubber insulating line hose and covers, respectively.

TABLE E–3—GLOVE TESTS—WATER LEVEL [1] [2]

Class of glove	AC proof test		DC proof test	
	mm	in	mm	in
00	38	1.5	38	1.5
0	38	1.5	38	1.5
1	38	1.5	51	2.0
2	64	2.5	76	3.0
3	89	3.5	102	4.0
4	127	5.0	153	6.0

[1] The water level is given as the clearance from the reinforced edge of the glove to the water line, with a tolerance of ±13 mm. (±0.5 in.).
[2] If atmospheric conditions make the specified clearances impractical, the clearances may be increased by a maximum of 25 mm. (1 in.).

TABLE E–4—RUBBER INSULATING EQUIPMENT, VOLTAGE REQUIREMENTS

Class of equipment	Maximum use voltage [1] AC rms	Retest voltage [2] AC rms	Retest voltage [2] DC avg
00	500	2,500	10,000
0	1,000	5,000	20,000
1	7,500	10,000	40,000
2	17,000	20,000	50,000
3	26,500	30,000	60,000
4	36,000	40,000	70,000

[1] The maximum use voltage is the ac voltage (rms) classification of the protective equipment that designates the maximum nominal design voltage of the energized system that may be safely worked. The nominal design voltage is equal to the phase-to-phase voltage on multiphase circuits. However, the phase-to-ground potential is considered to be the nominal design voltage if:
(1) There is no multiphase exposure in a system area and the voltage exposure is limited to the phase-to-ground potential, or
(2) The electric equipment and devices are insulated or isolated or both so that the multiphase exposure on a grounded wye circuit is removed.
[2] The proof-test voltage shall be applied continuously for at least 1 minute, but no more than 3 minutes.

TABLE E–5—RUBBER INSULATING EQUIPMENT, TEST INTERVALS

Type of equipment	When to test
Rubber insulating line hose	Upon indication that insulating value is suspect and after repair.
Rubber insulating covers	Upon indication that insulating value is suspect and after repair.
Rubber insulating blankets	Before first issue and every 12 months thereafter;[1] upon indication that insulating value is suspect; and after repair.
Rubber insulating gloves	Before first issue and every 6 months thereafter;[1] upon indication that insulating value is suspect; after repair; and after use without protectors.
Rubber insulating sleeves	Before first issue and every 12 months thereafter;[1] upon indication that insulating value is suspect; and after repair.

[1] If the insulating equipment has been electrically tested but not issued for service, the insulating equipment may not be placed into service unless it has been electrically tested within the previous 12 months.

Subpart M—Fall Protection

■ 14. Revise the authority citation for Subpart M of part 1926 to read as follows:

Authority: 40 U.S.C. 3701 *et seq.;* 29 U.S.C. 653, 655, 657; Secretary of Labor's Order No. 1–90 (55 FR 9033), 6–96 (62 FR 111), 3–2000 (65 FR 50017), 5–2007 (72 FR 31159), or 1–2012 (77 FR 3912), as applicable; and 29 CFR Part 1911.

■ 15. Revise paragraphs (a)(2)(vi) and (a)(3)(iii) of § 1926.500 to read as follows:

§ 1926.500 Scope, application, and definitions applicable to this subpart.

(a) * * *

(2) * * *

(vi) Subpart V of this part provides requirements relating to fall protection for employees working from aerial lifts or on poles, towers, or similar structures while engaged in the construction of electric transmission or distribution lines or equipment.

* * * * *

(3) * * *

(iii) Additional performance requirements for fall arrest and work-positioning equipment are provided in Subpart V of this part.

* * * * *

■ 16. Revise the authority citation for Subpart V of Part 1926 to read as follows:

Authority: 40 U.S.C. 3701 *et seq.;* 29 U.S.C. 653, 655, 657; Secretary of Labor's Order No. 1–2012 (77 FR 3912); and 29 CFR Part 1911.

■ 17. Revise Subpart V of Part 1926 to read as follows:

Subpart V—Electric Power Transmission and Distribution

Sec.

1926.950 General.
1926.951 Medical services and first aid.
1926.952 Job briefing.
1926.953 Enclosed spaces.
1926.954 Personal protective equipment.
1926.955 Portable ladders and platforms.
1926.956 Hand and portable power equipment.
1926.957 Live-line tools.
1926.958 Materials handling and storage.
1926.959 Mechanical equipment.
1926.960 Working on or near exposed energized parts.
1926.961 Deenergizing lines and equipment for employee protection.
1926.962 Grounding for the protection of employees.
1926.963 Testing and test facilities.
1926.964 Overhead lines and live-line barehand work.
1926.965 Underground electrical installations.
1926.966 Substations.
1926.967 Special conditions.
1926.968 Definitions.
Appendix A to Subpart V of Part 1926—[Reserved]
Appendix B to Subpart V of Part 1926—Working on Exposed Energized Parts
Appendix C to Subpart V of Part 1926—Protection from Hazardous Differences in Electric Potential
Appendix D to Subpart V of Part 1926—Methods of Inspecting and Testing Wood Poles
Appendix E to Subpart V of Part 1926—Protection from Flames and Electric Arcs
Appendix F to Subpart V of Part 1926—Work-Positioning Equipment Inspection Guidelines
Appendix G to Subpart V of Part 1926—Reference Documents

Subpart V—Electric Power Transmission and Distribution

§ 1926.950 General.

(a) *Application.* (1) *Scope.* (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.

(ii) Notwithstanding paragraph (a)(1)(i) of this section, this subpart does not apply to electrical safety-related work practices for unqualified employees.

(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.

(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.

(b) *Training.* (1) *All employees.* (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.

(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.

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

(2) *Qualified employees.* Each qualified employee shall also be trained and competent in:

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

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

(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,

(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

(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.

(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.

(4) *Additional training.* An employee shall receive additional training (or retraining) under any of the following conditions:

(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

(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

(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.

(5) *Type of training.* The training required by paragraph (b) of this section shall be of the classroom or on-the-job type.

(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.

(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.

(c) *Information transfer.* (1) *Host employer responsibilities.* Before work begins, the host employer shall inform contract employers of:

(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.

(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.

(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.

(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.

(2) *Contract employer responsibilities.* (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.

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

(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.

(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.

(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:

(1) The nominal voltages of lines and equipment,

(2) The maximum switching-transient voltages,

(3) The presence of hazardous induced voltages,

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

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

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

(7) The condition of poles, and

(8) Environmental conditions relating to safety.

§ 1926.951 Medical services and first aid.

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

(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:

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

(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.

§ 1926.952 Job briefing.

(a) *Before each job.* (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).

(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.

(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.

(c) *Number of briefings.* (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.

(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.

(d) *Extent of briefing.* (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.

(2) *Detailed discussion.* A more extensive discussion shall be conducted:

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

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

Note to paragraph (d): The briefing must address all the subjects listed in paragraph (b) of this section.

(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.

§ 1926.953 Enclosed spaces.

(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 shall meet the permit-space entry requirements of paragraphs (d) through (k) of § 1910.146 of this chapter.

(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.

(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.

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

(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.

(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.

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

(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.

(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.

(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 off-site evaluation. If continuous forced-air ventilation is provided, testing is not required provided that the procedures used ensure that employees are not exposed to the hazards posed by oxygen deficiency.

(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.

(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.

(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.

(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.

(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 paragraphs (d) through (k) of § 1910.146 of this chapter are considered as complying with this section.

§ 1926.954 Personal protective equipment.

(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).

(b) *Fall protection.* (1) *Personal fall arrest systems.* (i) Personal fall arrest systems shall meet the requirements of Subpart M of this part.

(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.

(2) *Work-positioning equipment.* Body belts and positioning straps for work-positioning equipment shall meet the following requirements:

(i) Hardware for body belts and positioning straps shall meet the following requirements:

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

(B) Hardware shall have a corrosion-resistant finish.

(C) Hardware surfaces shall be smooth and free of sharp edges.

(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).

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

(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.

(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.

(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.

(vii) Positioning straps shall be capable of withstanding the following tests:

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

(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.

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

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

(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.	

(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.

(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.

(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.

(xi) Snaphooks shall be of the locking type meeting the following requirements:

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

(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.

(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).

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

(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).

(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.

(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.

(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.

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

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

Note to paragraph (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.

(3) *Care and use of personal fall protection equipment.* (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.

(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.

(iii) The employer shall ensure that employees use fall protection systems as follows:

(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.

(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.

(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 must use fall protection equipment unless the employer can demonstrate that climbing or changing location with fall protection is infeasible or creates a greater hazard than climbing or changing location without it.

Note 1 to paragraphs (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 § 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.

(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).

(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 kilonewtons (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.

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

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

(B) To each other;

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

(D) To a horizontal lifeline; or

(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.

§ 1926.955 Portable ladders and platforms.

(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.

(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:

(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.

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

(3) *Securing in place.* Portable ladders and platforms shall be secured to prevent them from becoming dislodged.

(4) *Intended use.* Portable ladders and platforms may be used only in applications for which they are designed.

(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.

§ 1926.956 Hand and portable power equipment.

(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.

(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):

(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

(2) The equipment shall be of the double-insulated type conforming to Subpart K of this part; or

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

(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:

(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.

(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.

(3) *Bonding the frame.* For vehicle-mounted generators, the frame of the generator shall be bonded to the vehicle frame.

(4) *Bonding the neutral conductor.* Any neutral conductor shall be bonded to the generator frame.

(d) *Hydraulic and pneumatic tools.* (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.

(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.

(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.

(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.

(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.

(6) *Breaking connections.* Pressure shall be released before connections are broken, unless quick-acting, self-closing connectors are used.

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

(8) *Hoses.* Hoses may not be kinked.

§ 1926.957 Live-line tools.

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

(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.

(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

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

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

(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.

(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:

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

(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.

(iii) The tool shall be tested in accordance with paragraphs (b)(3)(iv)

and (b)(3)(v) of this section under the following conditions:

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

(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.

(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.

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

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

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

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

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

§ 1926.958 Materials handling and storage.

(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.

(b) *Materials storage near energized lines or equipment.* (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:

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

(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.

(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.

§ 1926.959 Mechanical equipment.

(a) *General requirements.* (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.

(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.

(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.

(b) *Outriggers.* (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.

(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.

(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.

(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.

(d) *Operations near energized lines or equipment.* (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.

(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.

(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.

(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.

(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).

(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:

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

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

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

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

Note to 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.

§ 1926.960 Working on or near exposed energized parts.

(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.

(b) *General.* (1) *Qualified employees only.* (i) Only qualified employees may work on or with exposed energized lines or parts of equipment.

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

(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.

(3) *At least two employees.* (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:

(A) Installation, removal, or repair of lines energized at more than 600 volts,

(B) Installation, removal, or repair of deenergized lines if an employee is exposed to contact with other parts energized at more than 600 volts,

(C) Installation, removal, or repair of equipment, such as transformers, capacitors, and regulators, if an employee is exposed to contact with parts energized at more than 600 volts,

(D) Work involving the use of mechanical equipment, other than insulated aerial lifts, near parts energized at more than 600 volts, and

(E) Other work that exposes an employee to electrical hazards greater than, or equal to, the electrical hazards posed by operations listed specifically in paragraphs (b)(3)(i)(A) through (b)(3)(i)(D) of this section.

(ii) Paragraph (b)(3)(i) of this section does not apply to the following operations:

(A) Routine circuit switching, when the employer can demonstrate that conditions at the site allow safe performance of this work,

(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

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

(c) *Live work.* (1) *Minimum approach distances.* (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.

(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 overvoltages.

(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:

(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

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

(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).

(2) *Type of insulation.* (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:

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

(B) When installing insulation for purposes of paragraph (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.

(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:

(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

(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.

(d) *Working position.* (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.

(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.

(e) *Making connections.* The employer shall ensure that employees make connections as follows:

(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;

(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

(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.

(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.

(g) *Protection from flames and electric arcs.* (1) *Hazard assessment.* The employer shall assess the workplace to identify employees exposed to hazards from flames or from electric arcs.

(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.

(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.

(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:

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

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

(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.

(iv) The incident heat energy estimated under paragraph (g)(2) of this section exceeds 2.0 cal/cm^2.

(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/cm^2. This protective equipment shall cover the employee's entire body, except as follows:

(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/cm^2, heavy-duty leather work gloves with a weight of at least 407 gm/m^2 (12 oz/yd^2),

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

(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/cm^2 for exposures involving single-phase arcs in open air or 5 cal/cm^2 for other exposures,

(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/cm^2 if the estimated incident-energy exposure is less than 13 cal/cm^2 for exposures involving single-phase arcs in open air or 9 cal/cm^2 for other exposures, and

(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/cm^2 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.

(6) *Dates.* (i) The obligation in paragraph (g)(2) of this section for the employer to make reasonable estimates of incident energy commences January 1, 2015.

(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/cm^2 commences April 1, 2015.

(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.

(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.

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

(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.

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

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

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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 5 kV: [1]		
$MAD = M + D$, where		
$D =$	0.02 m	the electrical component of the minimum approach distance
$M =$	0.31 m for voltages up to 750 V and 0.61 m otherwise	the inadvertent movement factor
For phase-to-phase system voltages of 5.1 kV to 72.5 kV: [1 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

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Table V-2 (Continued)

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

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

$C =$ 0.01 for phase-to-ground exposures that the employer can demonstrate consist only of air across the approach distance (gap),
0.01 for phase-to-phase exposures if the employer can demonstrate that no insulated tool spans the gap and that no large conductive object is in the gap, or
0.011 otherwise

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

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

$A =$ altitude correction factor from Table V-4

$M =$ 0.31 m, the inadvertent movement factor

$a =$ saturation factor, as follows:

Phase-to-Ground Exposures					
$V_{Peak} = T_{L-G}V_{L-G}\sqrt{2}$	635 kV or less	635.1 to 915 kV	915.1 to 1,050 kV	More than 1,050 kV	
a	0	$(V_{Peak}$- 635)/140,000	$(V_{Peak}$-645)/135,000	$(V_{Peak}$-675)/125,000	
Phase-to-Phase Exposures[3]					
$V_{Peak} = (1.35T_{L-G} + 0.45)V_{L-G}\sqrt{2}$	630 kV or less	630.1 to 848 kV	848.1 to 1,131 kV	1,131.1 to 1,485 kV	More than 1,485 kV
a	0	$(V_{Peak}$-630)/155,000	$(V_{Peak}$-633.6)/152,207	$(V_{Peak}$-628)/153,846	$(V_{Peak}$-350.5)/203,666

[1]Employers may use the minimum approach distances in Table 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 (3,000 feet), see footnote 1 to Table V-6. Employers may use the minimum approach distances 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 object is in the gap.

[4]Until March 31, 2015, employers 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

§ 1926.961 Deenergizing lines and equipment for employee protection.

(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.

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

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

(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.

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

(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

(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.

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

(c) *Deenergizing lines and equipment.* (1) *Request to deenergize.* The employee that the employer designates pursuant to 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.

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

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

(4) *Network protectors.* The employer need not use the tags mentioned in 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:

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

(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

(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.

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

(6) *Test for energized condition.* After the applicable requirements in 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.

(7) *Install grounds.* The employer shall ensure the installation of protective grounds as required by § 1926.962.

(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.

(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.

(10) *Releasing clearances.* To release a clearance, the employee in charge shall:

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

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

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

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

(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.

(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.

(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.

§ 1926.962 Grounding for the protection of employees.

(a) *Application.* This section applies to grounding of transmission and distribution lines and equipment for the purpose of protecting employees. 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.

(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:

(1) *Deenergized.* The employer ensures that the lines and equipment are deenergized under the provisions of § 1926.961.

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

(3) *No induced voltage.* The hazard of induced voltage is not present.

(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.

(d) *Protective grounding equipment.* (1) *Ampacity.* (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.

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

(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.

(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.

(f) *Connecting and removing grounds.* (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.

(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.

(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.

(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.

§ 1926.963 Testing and test facilities.

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

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.

(b) *General requirements.* (1) *Safe work practices.* The employer shall establish and enforce work practices for the protection of each worker from the hazards of high-voltage or high-power testing at all test areas, temporary and permanent. Such work practices shall include, 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.

(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).

(c) *Safeguarding of test areas.* (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.

(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.

(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:

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

(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

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

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

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

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

(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.

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

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

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

(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.

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

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

(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.

(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.

(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.

(e) *Control and measuring circuits.* (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.

(2) *Instruments.* The employer shall isolate meters and other instruments

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

(3) *Routing 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.

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

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

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

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

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

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

(iv) Ground connections are clearly identifiable;

(v) Personal protective equipment is provided and used as required by Subpart E of this part and by this subpart; and

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

§ 1926.964 Overhead lines and live-line barehand work.

(a) *General.* (1) *Application.* This section provides additional requirements for work performed on or near overhead lines and equipment and for live-line barehand work.

(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.

(3) *Setting and moving poles.* (i) When a pole is set, moved, or removed near an exposed energized overhead conductor, the pole may not contact the conductor.

(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.

(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.

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

(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.

(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:

(i) Failure of the pulling or tensioning equipment,

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

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

(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.

(4) *Induced voltage.* (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.

(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.

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

(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.

(7) *Defective pulling lines.* The employer shall repair or replace defective pulling lines and accessories.

(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.

(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.

(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.

(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.

(c) *Live-line barehand work.* In addition to other applicable provisions contained in this subpart, the following requirements apply to live-line barehand work:

(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.

(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):

(i) The nominal voltage rating of the circuit on which employees will perform the work,

(ii) The clearances to ground of lines and other energized parts on which employees will perform the work, and

(iii) The voltage limitations of equipment employees will use.

(3) *Insulated tools and equipment.* (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.

(ii) The employer shall ensure that employees keep tools and equipment clean and dry while they are in use.

(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.

(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.

(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.

(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.

(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.

(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.

(8) *Aerial-lift controls.* Aerial lifts used for live-line barehand work shall have dual controls (lower and upper) as follows:

(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.

(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.

(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.

(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.

(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.

(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.

(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.

(ii) The leakage current may not exceed 1 microampere per kilovolt of nominal phase-to-ground voltage.

(iii) The employer shall immediately suspend work from the aerial lift when there is any indication of a malfunction in the equipment.

(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.

(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.

(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.

(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.

(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.

(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.

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

(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.

(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.

(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.

(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.

§ 1926.965 Underground electrical installations.

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

(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.

(c) *Lowering equipment into manholes.* (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.

(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.

(d) *Attendants for manholes and vaults.* (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.

(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.

(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.

(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.

(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.

(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.

(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.

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

(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.

(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.

§ 1926.966 Substations.

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

(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.

(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.

(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.

(e) *Guarding of rooms and other spaces containing electric supply equipment.* (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:

(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,

(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

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

(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

(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.

(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.

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

(4) *Warning signs.* The employer shall display signs at entrances to the rooms and other spaces warning unqualified persons to keep out.

(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.

(f) *Guarding of energized parts.* (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.

(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.

(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.

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

(2) *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.

§ 1926.967 Special conditions.

(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.

(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,

(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.

(3) *Short circuiting connected lines.* The employer shall short circuit any line connected to capacitors before the line is treated as deenergized.

(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.

(c) *Series streetlighting.* (1) *Applicable requirements.* If the open-circuit voltage exceeds 600 volts, the employer shall ensure that employees work on series streetlighting circuits in accordance with § 1926.964 or § 1926.965, as appropriate.

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

(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.

(e) *Protection against drowning.* (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.

(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.

(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.

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

(g) *Employee protection in public work areas.* (1) *Traffic control devices.* Traffic-control signs and traffic-control devices used for the protection of employees shall meet § 1926.200(g)(2).

(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.

(3) *Barricades.* The employer shall use barricades where additional employee protection is necessary.

(4) *Excavated areas.* The employer shall protect excavated areas with barricades.

(5) *Warning lights.* The employer shall display warning lights prominently at night.

(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 § 1926.960 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.

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

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

(k) *Communication facilities.* (1) *Microwave transmission.* (i) The employer shall ensure that no employee looks into an open waveguide or antenna connected to an energized microwave source.

(ii) If the electromagnetic-radiation level within an accessible area associated with microwave communications systems exceeds the radiation-protection guide 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."

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

(2) *Power-line carrier.* 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.

§ 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.

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, § 1926.1200, 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 section, 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.

Appendix A to Subpart V of Part 1926—[Reserved]

Appendix B to Subpart V of Part 1926—Working on Exposed Energized Parts

I. Introduction

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

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

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 overvoltages 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.

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.

Normal system design may provide or include a means (such as lightning arrestors) to control maximum anticipated transient overvoltages, or the employer may use temporary devices (portable protective gaps) or measures (such as preventing automatic circuit breaker reclosing) to achieve the same result. 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 overvoltages.

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

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

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

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

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

60 Hz rod-to-rod sparkover (kV peak)	Gap spacing from IEEE Std 4–1995 (cm)
25	2
36	3
46	4
53	5
60	6
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

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

overvoltage, which corresponds to the withstand voltage for the relevant exposure.[3]

4. Divide the maximum phase-to-ground transient overvoltage by 0.85 to determine the corresponding critical sparkover voltage. (The critical sparkover voltage is 3 standard deviations (or 15 percent) greater than the withstand voltage.)

5. Determine the electrical component of the minimum approach distance from Table 1 through interpolation.

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

TABLE 2—CALCULATING THE ELECTRICAL COMPONENT OF MAD—751 V TO 72.5 KV

Step	Maximum system phase-to-phase voltage (kV)			
	15	36	46	72.5
1. Divide by √3	8.7	20.8	26.6	41.9
2. Multiply by √3	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 subpart bases the electrical component of minimum approach distances, before the application of any altitude correction factor, on the following formula:

Equation 1—For voltages of 72.6 kV to 800 kV

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

Where:

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

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

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

$V_{L\text{-}G}$ = Maximum system line-to-ground rms voltage in kilovolts—it should be the "actual" maximum, or the normal highest voltage for the range (for example, 10 percent above the nominal voltage); and

T = Maximum transient overvoltage factor in per unit.

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

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}.

[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.

[4] Test data demonstrates that the saturation factor is greater than 0 at peak voltages of about 630 kilovolts. Systems operating at 345 kilovolts (or maximum system voltages of 362 kilovolts) can have peak maximum transient overvoltages exceeding 630 kilovolts. Table V–2 sets equations for calculating a based on peak voltage.

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

Phase-to-Ground Exposures			
$V_{Peak} = T_{L\text{-}G} V_{L\text{-}G} \sqrt{2}$	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
$V_{Peak} = T_{L\text{-}G} V_{L\text{-}G} \sqrt{2}$	More than 1,050 kV		
a	$(V_{Peak}$-675)/125,000		
Phase-to-Phase Exposures[1]			
$V_{Peak} = (1.35T_{L\text{-}G} + 0.45)V_{L\text{-}G}\sqrt{2}$	630 kV or less	630.1 to 848 kV	848.1 to 1,131 kV
a	0	$(V_{Peak}$-630)/155,000	$(V_{Peak}$-633.6)/152,207
$V_{Peak} = (1.35T_{L\text{-}G} + 0.45)V_{L\text{-}G}\sqrt{2}$	1,131.1 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 $T_{L\text{-}G}$, as T in Equation 1. IEEE Std 516–2009 provides the following formula to calculate the phase-to-phase maximum transient overvoltage, $T_{L\text{-}L}$, from $T_{L\text{-}G}$:

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

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

D. *Provisions for inadvertent movement.* The minimum approach distance must include an "adder" to compensate for the inadvertent movement of the worker relative to an energized part or the movement of the part relative to the worker. This "adder" must account for this possible inadvertent movement and provide the worker with a comfortable and safe zone in which to work. Employers must add the distance for inadvertent movement (called the "ergonomic component of the minimum approach distance") to the electrical component to determine the total safe minimum approach distances used in live-line work.

The Occupational Safety and Health Administration based the ergonomic component of the minimum approach distance on response time-distance analysis. This technique uses an estimate of the total response time to a hazardous incident and converts that time to the distance traveled. For example, the driver of a car takes a given amount of time to respond to a "stimulus" and stop the vehicle. The elapsed time involved results in the car's traveling some distance before coming to a complete stop. This distance depends on the speed of the car at the time the stimulus appears and the reaction time of the driver.

In the case of live-line work, the employee must first perceive that he or she is approaching the danger zone. Then, the worker responds to the danger and must decelerate and stop all motion toward the energized part. During the time it takes to stop, the employee will travel some distance. This is the distance the employer must add to the electrical component of the minimum approach distance to obtain the total safe minimum approach distance.

At voltages from 751 volts to 72.5 kilovolts,[5] the electrical component of the minimum approach distance is smaller than the ergonomic component. At 72.5 kilovolts, the electrical component is only a little more than 0.3 meters (1 foot). An ergonomic component of the minimum approach distance must provide for all the worker's unanticipated movements. At these voltages, workers generally use rubber insulating gloves; however, these gloves protect only a worker's hands and arms. Therefore, the energized object must be at a safe approach distance to protect the worker's face. In this case, 0.61 meters (2 feet) is a sufficient and practical ergonomic component of the minimum approach distance.

For voltages between 72.6 and 800 kilovolts, employees must use different work practices during energized line work. Generally, employees use live-line tools (hot sticks) to perform work on energized equipment. These tools, by design, keep the energized part at a constant distance from the employee and, thus, maintain the appropriate minimum approach distance automatically.

The location of the worker and the type of work methods the worker is using also influence the length of the ergonomic component of the minimum approach distance. In this higher voltage range, the employees use work methods that more tightly control their movements than when the workers perform work using rubber insulating gloves. The worker, therefore, is farther from the energized line or equipment and must be more precise in his or her movements just to perform the work. For these reasons, this subpart adopts an ergonomic component of the minimum approach distance of 0.31 m (1 foot) for voltages between 72.6 and 800 kilovolts.

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

[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—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.

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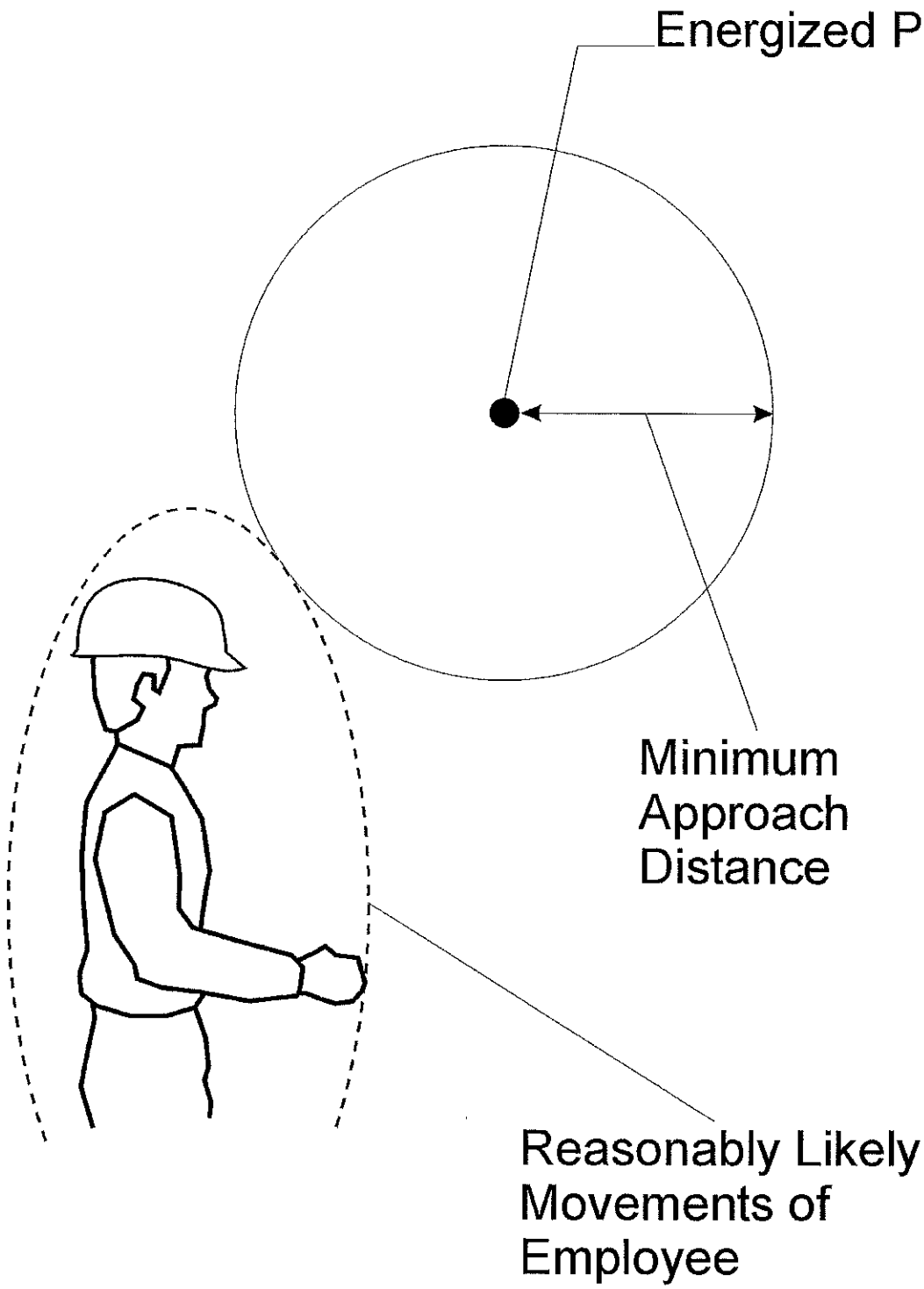

Figure 1—Maintaining the Minimum Approach Distance

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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

[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.

characteristics of the applied voltage (wave shape) affect the disruptive gradient.

2. *Atmospheric effect.* The empirically determined electrical strength of a given gap is normally applicable at standard atmospheric conditions (20 °C, 101.3 kilopascals, 11 grams/cubic centimeter humidity). An increase in the density (humidity) of the air inhibits sparkover for a given air gap. The combination of temperature and air pressure that results in the lowest gap sparkover voltage is high temperature and low pressure. This combination of conditions is not likely to occur. Low air pressure, generally associated with high humidity, causes increased electrical strength. An average air pressure generally correlates with low humidity. Hot and dry working conditions normally result in reduced electrical strength. The equations for minimum approach distances in Table 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 overvoltages.* Operation of switches or circuit breakers, a fault on a line or circuit or on an adjacent circuit, and similar activities may generate transient overvoltages on an electrical system. Each overvoltage has an associated transient voltage wave shape. The wave shape arriving at the site and its magnitude vary considerably.

In developing requirements for minimum approach distances, the Occupational Safety and Health Administration considered the most common wave shapes and the magnitude of transient overvoltages found on electric power generation, transmission, and distribution systems. The equations in Table V–2 for minimum approach distances use per-unit maximum transient overvoltages, which are relative to the nominal maximum voltage of the system. For example, a maximum transient overvoltage value of 3.0 per unit indicates that the highest transient overvoltage is 3.0 times the nominal maximum system voltage.

3. *Typical magnitude of overvoltages.* Table 5 lists the magnitude of typical transient overvoltages.

TABLE 5—MAGNITUDE OF TYPICAL TRANSIENT OVERVOLTAGES

Cause	Magnitude (per unit)
Energized 200-mile line without closing resistors	3.5
Energized 200-mile line with one-step closing resistor	2.1
Energized 200-mile line with multistep resistor	2.5
Reclosing with trapped charge one-step resistor	2.2
Opening surge with single restrike	3.0
Fault initiation unfaulted phase	2.1
Fault initiation adjacent circuit	2.5
Fault clearing	1.7 to 1.9

4. *Standard deviation—air-gap withstand.* For each air gap length under the same atmospheric conditions, there is a statistical variation in the breakdown voltage. The probability of breakdown against voltage has a normal (Gaussian) distribution. The standard deviation of this distribution varies with the wave shape, gap geometry, and atmospheric conditions. The withstand voltage of the air gap is three standard deviations (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 Overvoltages

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-to-ground, 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 overvoltages) produces unacceptably large minimum approach distances:

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

Step 2. Determine the technique to use to control the maximum transient overvoltage. (See paragraphs IV.C and IV.D of this appendix.) Determine the maximum transient overvoltage that can exist at the worksite with that form of control in place and with a confidence level of 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 overvoltages that occur on transmission systems. For example, the employer can modify the operation of circuit breakers or other switching devices to reduce switching transient overvoltages. Alternatively, the employer can hold the overvoltage to an acceptable level by installing surge arresters or portable

protective gaps on the system. In addition, the employer can change the transmission system to minimize the effect of switching operations. Section 4.8 of IEEE Std 516–2009 describes various ways of controlling, and thereby reducing, maximum transient overvoltages.

2. *Operation of circuit breakers.*[7] The maximum transient overvoltage that can reach the worksite is often the result of switching on the line on which employees are working. Disabling automatic reclosing during energized line work, so that the line will not be reenergized after being opened for any reason, limits the maximum switching surge overvoltage to the larger of the opening surge or the greatest possible fault-generated surge, provided that the devices (for example, insertion resistors) are operable and will function to limit the transient overvoltage and that circuit breaker restrikes do not occur. The employer must ensure the proper functioning of insertion resistors and other overvoltage-limiting devices when the employer's engineering analysis assumes their proper operation to limit the overvoltage level. If the employer cannot disable the reclosing feature (because of system operating conditions), other methods of controlling the switching surge level may be necessary.

Transient surges on an adjacent line, particularly for double circuit construction, may cause a significant overvoltage on the line on which employees are working. The employer's engineering analysis must account for coupling to adjacent lines.

3. *Surge arresters.* The use of modern surge arresters allows a reduction in the basic impulse-insulation levels of much transmission system equipment. The primary function of early arresters was to protect the system insulation from the effects of lightning. Modern arresters not only dissipate lightning-caused transients, but may also control many other system transients caused by switching or faults.

The employer may use properly designed arresters to control transient overvoltages along a transmission line and thereby reduce the requisite length of the insulator string and possibly the maximum transient overvoltage on the line.[8]

4. *Switching Restrictions.* Another form of overvoltage control involves establishing switching restrictions, whereby the employer prohibits the operation of circuit breakers until certain system conditions are present. The employer restricts switching by using a tagging system, similar to that used for a permit, except that the common term used for this activity is a "hold-off" or "restriction." These terms indicate that the restriction does not prevent operation, but only modifies the operation during the live-work activity.

D. Minimum Approach Distance Based on Control of Maximum Transient Overvoltage at the Worksite

When the employer institutes control of maximum transient overvoltage at the worksite by installing portable protective gaps, the employer may calculate the minimum approach distance as follows:

Step 1. Select the appropriate withstand voltage for the protective gap based on system requirements and an acceptable probability of gap sparkover.[9]

Step 2. Determine a gap distance that provides a withstand voltage[10] greater than or equal to the one selected in the first step.[11]

Step 3. Use 110 percent of the gap's critical sparkover voltage to determine the phase-to-ground peak voltage at gap sparkover ($V_{PPG\ Peak}$).

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

$$T = \frac{V_{PPG\,Peak}}{V_{L\text{-}G}\sqrt{2}}.$$

Step 5. Use this value of T[12] in the equation in Table 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).

Sample protective gap calculations.

Problem: Employees are to perform work on a 500-kilovolt transmission line at sea level that is subject to transient overvoltages of 2.4 p.u. The maximum operating voltage of the line is 550 kilovolts. Determine the length of the protective gap that will provide the minimum practical safe approach distance. Also, determine what that minimum approach distance is.

Step 1. Calculate the smallest practical maximum transient overvoltage (1.25 times the crest phase-to-ground voltage):[13]

$$550kV \times \frac{\sqrt{2}}{\sqrt{3}} \times 1.25 = 561kV.$$

This value equals the withstand voltage of the protective gap.

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

$561kV \div 0.85 = 660kV$

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:

$MAD = 2.29m(7.6ft)$

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 overvoltages on the line that exceed the withstand voltage of the gap. Consequently, the employer must protect employees from hazards resulting from any sparkover that could occur.

[7] The detailed design of a circuit interrupter, such as the design of the contacts, resistor insertion, and breaker timing control, are beyond the scope of this appendix. The design of the system generally accounts for these features. This appendix only discusses features that can limit the maximum switching transient overvoltage on a system.

[8] Surge arrester application is beyond the scope of this appendix. However, if the employer installs the arrester near the work site, the application would be similar to the protective gaps discussed in paragraph IV.D of this appendix.

[9] The employer should check the withstand voltage to ensure that it results in a probability of gap flashover that is acceptable from a system outage perspective. (In other words, a gap sparkover will produce a system outage. The employer should determine whether such an outage will impact overall system performance to an acceptable degree.) In general, the withstand voltage should be at least 1.25 times the maximum crest operating voltage.

[10] The manufacturer of the gap provides, based on test data, the critical sparkover voltage for each gap spacing (for example, a critical sparkover voltage of 665 kilovolts for a gap spacing of 1.2 meters). The withstand voltage for the gap is equal to 85 percent of its critical sparkover voltage.

[11] Switch steps 1 and 2 if the length of the protective gap is known.

[12] IEEE Std 516–2009 states that most employers add 0.2 to the calculated value of T as an additional safety factor.

[13] To eliminate sparkovers due to minor system disturbances, the employer should use a withstand voltage no lower than 1.25 p.u. Note that this is a practical, or operational, consideration only. It may be feasible for the employer to use lower values of withstand voltage.

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-phase 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

*The minimum approach distance may be the shortest distance between the energized part and the grounded surface.

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-phase exposure	
	m	ft	m	ft
1.5	0.67	2.2	0.84	2.8
1.6	0.69	2.3	0.87	2.9
1.7	0.71	2.3	0.90	3.0
1.8	0.74	2.4	0.93	3.1
1.9	0.76	2.5	0.96	3.1
2.0	0.78	2.6	0.99	3.2
2.1	0.81	2.7	1.01	3.3
2.2	0.83	2.7	1.04	3.4
2.3	0.85	2.8	1.07	3.5
2.4	0.88	2.9	1.10	3.6
2.5	0.90	3.0	1.13	3.7
2.6	0.92	3.0	1.16	3.8
2.7	0.95	3.1	1.19	3.9
2.8	0.97	3.2	1.22	4.0
2.9	0.99	3.2	1.24	4.1
3.0	1.02	3.3	1.27	4.2
3.1	1.04	3.4	1.30	4.3
3.2	1.06	3.5	1.33	4.4
3.3	1.09	3.6	1.36	4.5
3.4	1.11	3.6	1.39	4.6
3.5	1.13	3.7	1.42	4.7

TABLE 8—AC MINIMUM APPROACH DISTANCES—121.1 TO 145.0 KV

T (p.u.)	Phase-to-ground rxposure		Phase-to-phase rxposure	
	m	ft	m	ft
1.5	0.74	2.4	0.95	3.1
1.6	0.76	2.5	0.98	3.2
1.7	0.79	2.6	1.02	3.3
1.8	0.82	2.7	1.05	3.4
1.9	0.85	2.8	1.08	3.5
2.0	0.88	2.9	1.12	3.7
2.1	0.90	3.0	1.15	3.8
2.2	0.93	3.1	1.19	3.9

TABLE 8—AC MINIMUM APPROACH DISTANCES—121.1 TO 145.0 KV—Continued

T (p.u.)	Phase-to-ground rxposure		Phase-to-phase rxposure	
	m	ft	m	ft
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-phase 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-phase exposure	
	m	ft	m	ft
1.5	1.02	3.3	1.37	4.5
1.6	1.06	3.5	1.43	4.7
1.7	1.11	3.6	1.48	4.9
1.8	1.16	3.8	1.54	5.1
1.9	1.21	4.0	1.60	5.2
2.0	1.25	4.1	1.66	5.4
2.1	1.30	4.3	1.73	5.7
2.2	1.35	4.4	1.81	5.9
2.3	1.39	4.6	1.90	6.2
2.4	1.44	4.7	1.99	6.5
2.5	1.49	4.9	2.08	6.8
2.6	1.53	5.0	2.17	7.1
2.7	1.58	5.2	2.26	7.4
2.8	1.63	5.3	2.36	7.7
2.9	1.67	5.5	2.45	8.0
3.0	1.72	5.6	2.55	8.4
3.1	1.77	5.8	2.65	8.7
3.2	1.81	5.9	2.76	9.1
3.3	1.88	6.2	2.86	9.4
3.4	1.95	6.4	2.97	9.7
3.5	2.01	6.6	3.08	10.1

TABLE 11—AC MINIMUM APPROACH DISTANCES—242.1 TO 362.0 KV

T (p.u.)	Phase-to-ground exposure		Phase-to-phase exposure	
	m	ft	m	ft
1.5	1.37	4.5	1.99	6.5
1.6	1.44	4.7	2.13	7.0
1.7	1.51	5.0	2.27	7.4
1.8	1.58	5.2	2.41	7.9
1.9	1.65	5.4	2.56	8.4
2.0	1.72	5.6	2.71	8.9
2.1	1.79	5.9	2.87	9.4
2.2	1.87	6.1	3.03	9.9
2.3	1.97	6.5	3.20	10.5
2.4	2.08	6.8	3.37	11.1
2.5	2.19	7.2	3.55	11.6
2.6	2.29	7.5	3.73	12.2
2.7	2.41	7.9	3.91	12.8
2.8	2.52	8.3	4.10	13.5
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-phase exposure	
	m	ft	m	ft
1.5	1.53	5.0	2.40	7.9
1.6	1.62	5.3	2.58	8.5
1.7	1.70	5.6	2.75	9.0
1.8	1.78	5.8	2.94	9.6
1.9	1.88	6.2	3.13	10.3
2.0	1.99	6.5	3.33	10.9
2.1	2.12	7.0	3.53	11.6
2.2	2.24	7.3	3.74	12.3
2.3	2.37	7.8	3.95	13.0
2.4	2.50	8.2	4.17	13.7
2.5	2.64	8.7	4.40	14.4
2.6	2.78	9.1	4.63	15.2
2.7	2.93	9.6	4.87	16.0
2.8	3.07	10.1	5.11	16.8
2.9	3.23	10.6	5.36	17.6
3.0	3.38	11.1	5.59	18.3
3.1	3.55	11.6	5.82	19.1
3.2	3.72	12.2	6.07	19.9
3.3	3.89	12.8	6.31	20.7
3.4	4.07	13.4	6.56	21.5
3.5	4.25	13.9	6.81	22.3

TABLE 13—AC MINIMUM APPROACH DISTANCES—420.1 TO 550.0 KV

T (p.u.)	Phase-to-ground exposure		Phase-to-phase 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

TABLE 13—AC MINIMUM APPROACH DISTANCES—420.1 TO 550.0 KV—Continued

T (p.u.)	Phase-to-ground exposure		Phase-to-phase exposure	
	m	ft	m	ft
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-phase exposure	
	m	ft	m	ft
1.5	3.16	10.4	5.97	19.6
1.6	3.46	11.4	6.43	21.1
1.7	3.78	12.4	6.92	22.7
1.8	4.12	13.5	7.42	24.3
1.9	4.47	14.7	7.93	26.0
2.0	4.83	15.8	8.47	27.8
2.1	5.21	17.1	9.02	29.6
2.2	5.61	18.4	9.58	31.4
2.3	6.02	19.8	10.16	33.3
2.4	6.44	21.1	10.76	35.3
2.5	6.88	22.6	11.38	37.3

Notes to Table 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.

Appendix C to Subpart V of Part 1926—Protection From Hazardous Differences in Electric Potential

I. Introduction

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

II. Voltage-Gradient Distribution

A. *Voltage-gradient distribution curve.* Absolute, or true, ground serves as a reference and always has a voltage of 0 volts above ground potential. Because there is an impedance between a grounding electrode and absolute ground, there will be a voltage difference between the grounding electrode and absolute ground under ground-fault conditions. Voltage dissipates from the grounding electrode (or from the grounding point) and creates a ground potential gradient. The voltage decreases rapidly with increasing distance from the grounding electrode. A voltage drop associated with this dissipation of voltage is a ground potential. Figure 1 is a typical voltage-gradient distribution curve (assuming a uniform soil texture).

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[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.

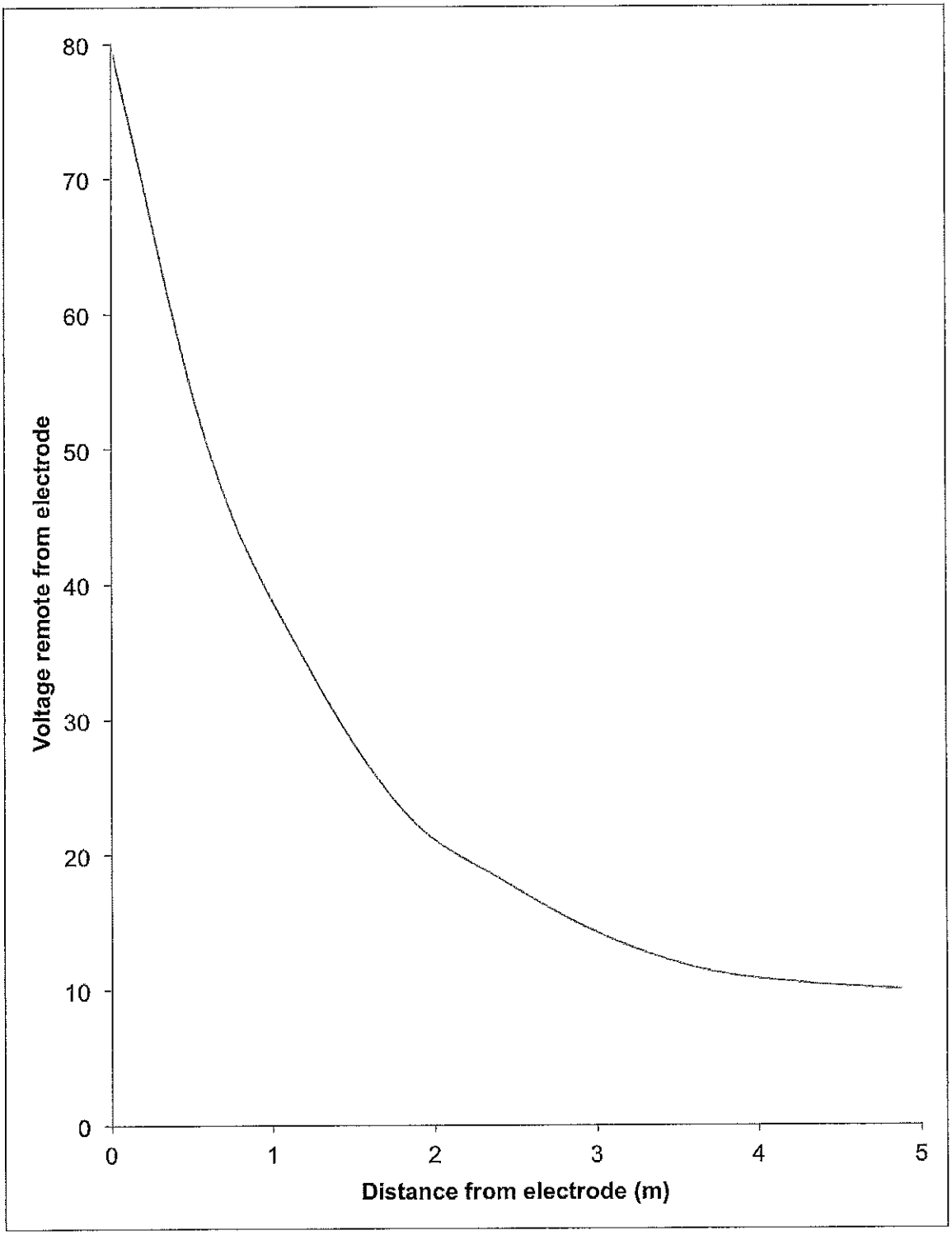

Figure 1—Typical Voltage-Gradient Distribution Curve

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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.

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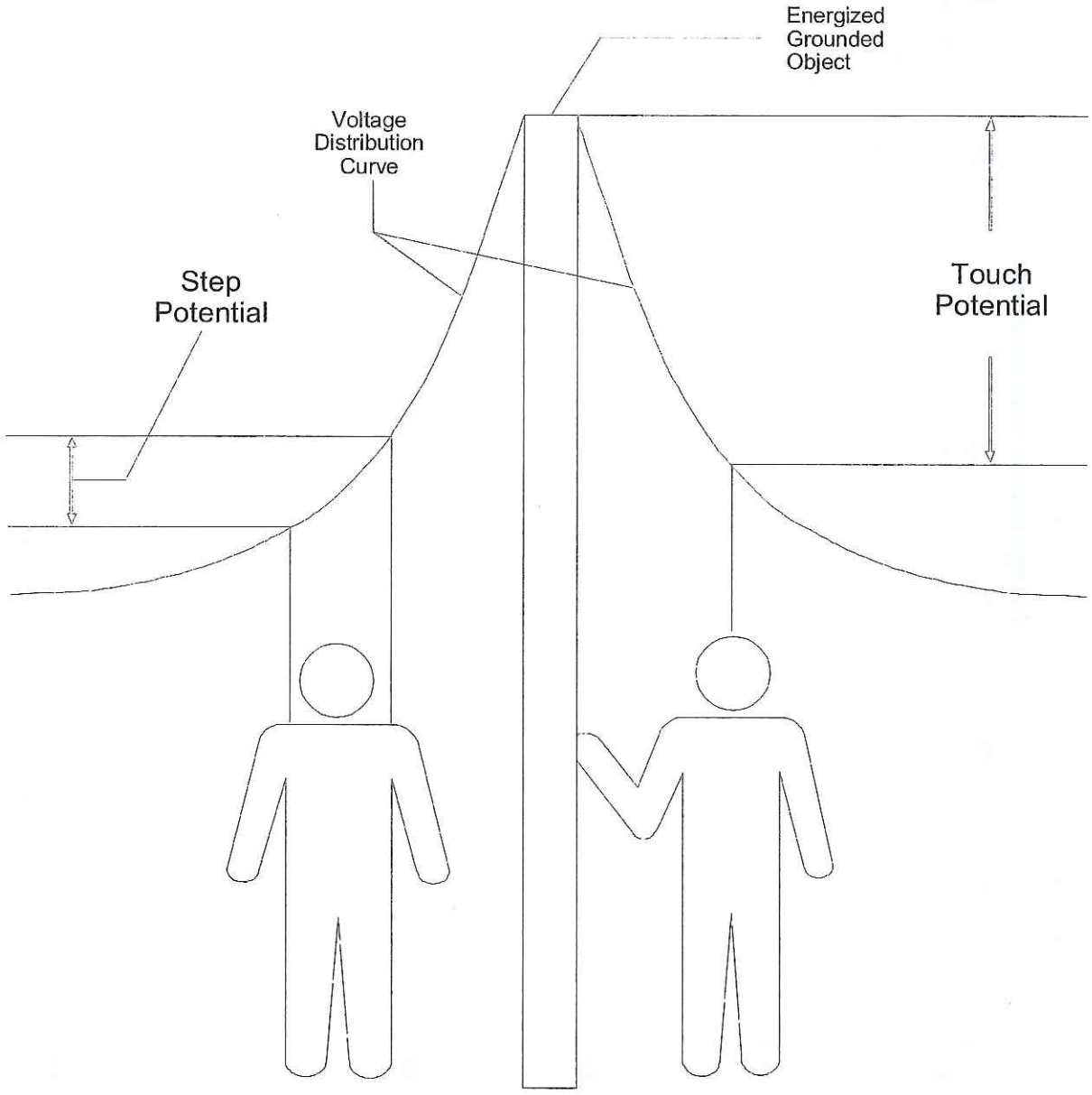

Figure 2—Step and Touch Potentials

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III. Protecting Workers From Hazardous Differences in Electrical Potential

A. *Definitions.* The following definitions apply to section III of this appendix:

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

Bonding cable (bonding jumper). A cable connected to two conductive parts to bond the parts together.

Cluster bar. A terminal temporarily attached to a structure that provides a means for the attachment and bonding of grounding and bonding cables to the structure.

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

Grounding cable (grounding jumper). A cable connected between a deenergized part

and ground. Note that grounding cables carry fault current and bonding cables generally do not. A cable that bonds two conductive parts but carries substantial fault current (for example, a jumper connected between one phase and a grounded phase) is a grounding cable.

Ground mat (grounding grid). A temporarily or permanently installed metallic mat or grating that establishes an equipotential surface and provides connection points for attaching grounds.

B. *Analyzing the hazard.* The employer can use an engineering analysis of the power system under fault conditions to determine whether hazardous step and touch voltages will develop. The analysis should determine the voltage on all conductive objects in the work area and the amount of time the voltage will be present. Based on the this analysis, the employer can select appropriate measures and protective equipment, including the measures and protective equipment outlined in Section III of this appendix, to protect each employee from hazardous differences in electric potential. For example, from the analysis, the employer will know the voltage remaining on conductive objects after employees install bonding and grounding equipment and will be able to select insulating equipment with an appropriate rating, as described in 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.

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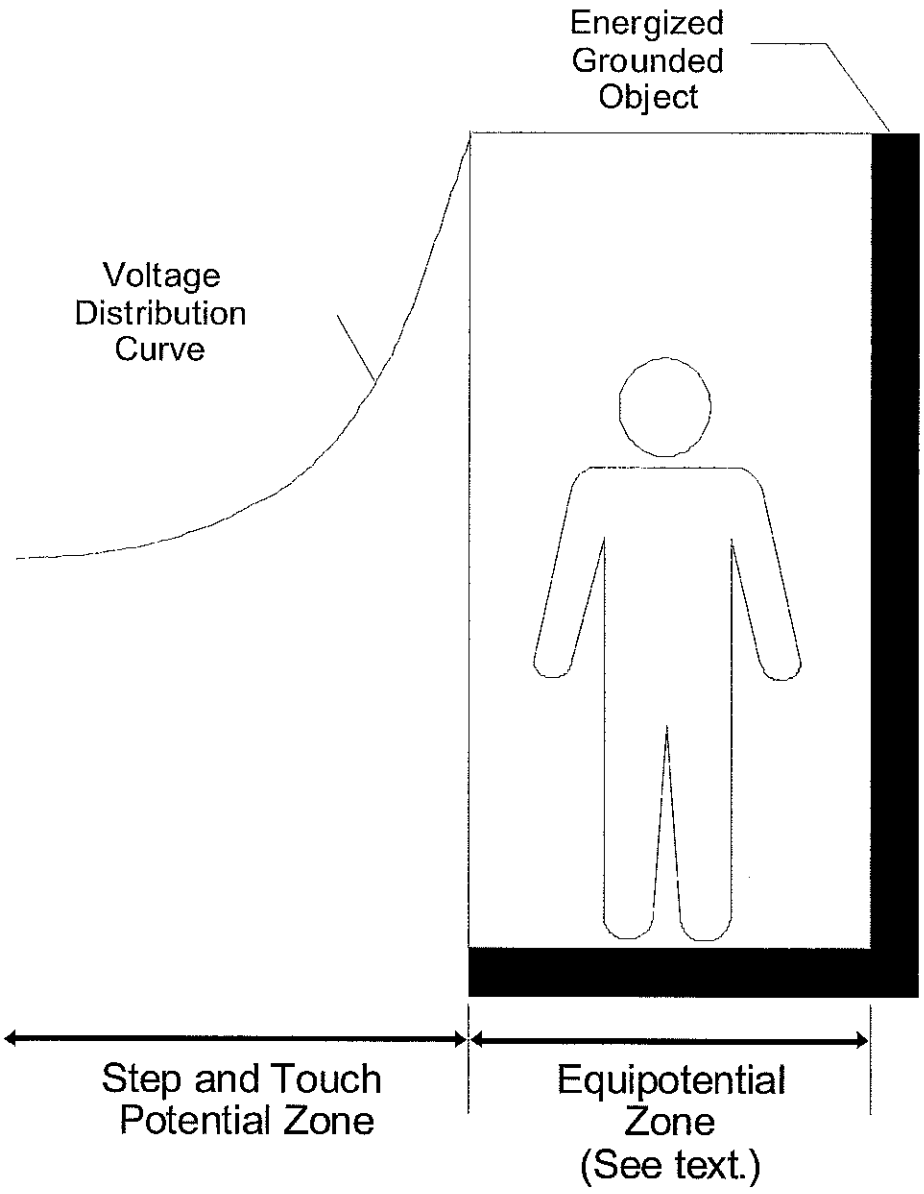

Figure 3—Protection from Ground-Potential Gradients

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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.

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*

[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.

Guide for Protective Grounding of Power Lines, provides the following equation for determining the threshold of ventricular fibrillation when the duration of the electric shock is limited:

$$I = \frac{116}{\sqrt{t}},$$

where I is the current through the worker's body, and t is the duration of the current in seconds. This equation represents the ventricular fibrillation threshold for 95.5 percent of the adult population with a mass of 50 kilograms (110 pounds) or more. The equation is valid for current durations between 0.0083 to 3.0 seconds.

To use this equation to set safe voltage limits in an equipotential zone around the worker, the employer will need to assume a value for the resistance of the worker's body. IEEE Std 1048–2003 states that "total body resistance is usually taken as 1000 Ω for determining . . . body current limits." However, employers should be aware that the impedance of a worker's body can be substantially less than that value. For instance, IEEE Std 1048–2003 reports a minimum hand-to-hand resistance of 610 ohms and an internal body resistance of 500 ohms. The internal resistance of the body better represents the minimum resistance of a worker's body when the skin resistance drops near zero, which occurs, for example, when there are breaks in the worker's skin, for instance, from cuts or from blisters formed as a result of the current from an electric shock, or when the worker is wet at the points of contact.

Employers may use the IEEE Std 1048–2003 equation to determine safe body current limits only if the employer protects workers from hazards associated with involuntary muscle reactions from electric shock (for example, the hazard to a worker from falling as a result of an electric shock). Moreover, the equation applies only when the duration of the electric shock is limited. If the precautions the employer takes, including those required by applicable standards, do not adequately protect employees from hazards associated with involuntary reactions from electric shock, a hazard exists if the induced voltage is sufficient to pass a current of 1 milliampere through a 500-ohm resistor. (The 500-ohm resistor represents the resistance of an employee. The 1-milliampere current is the threshold of perception.) Finally, if the employer protects employees from injury due to involuntary reactions from electric shock, but the duration of the electric shock is unlimited (that is, when the fault current at the work location will be insufficient to trip the devices protecting the circuit), a hazard exists if the resultant current would be more than 6 milliamperes (the recognized let-go threshold for workers [4]).

2. *Acceptable methods of grounding for employers that do not perform an engineering determination.* The grounding methods presented in this section of this appendix ensure that differences in electric potential are as low as possible and, therefore, meet § 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.

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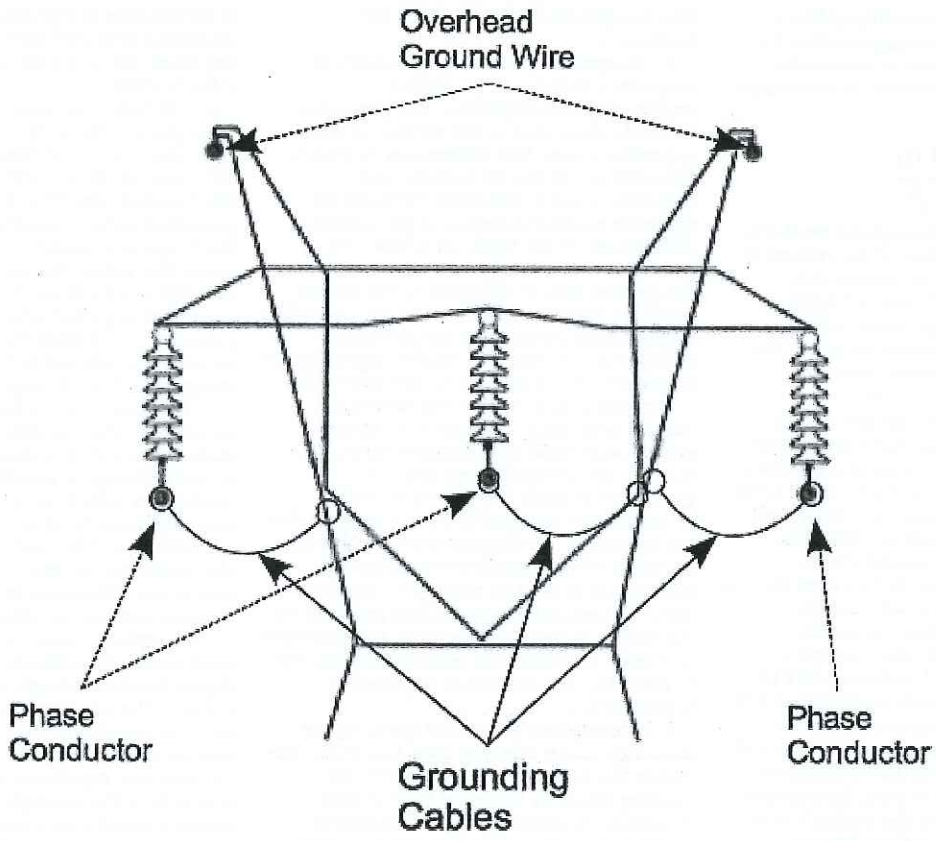
[4] Electric current passing through the body has varying effects depending on the amount of the current. At the let-go threshold, the current overrides a person's control over his or her muscles. At that level, an employee grasping an object will not be able to let go of the object. The let-go threshold varies from person to person; however, the recognized value for workers is 6 milliamperes.



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 4—Equipotential Zone for Metal Lattice Tower

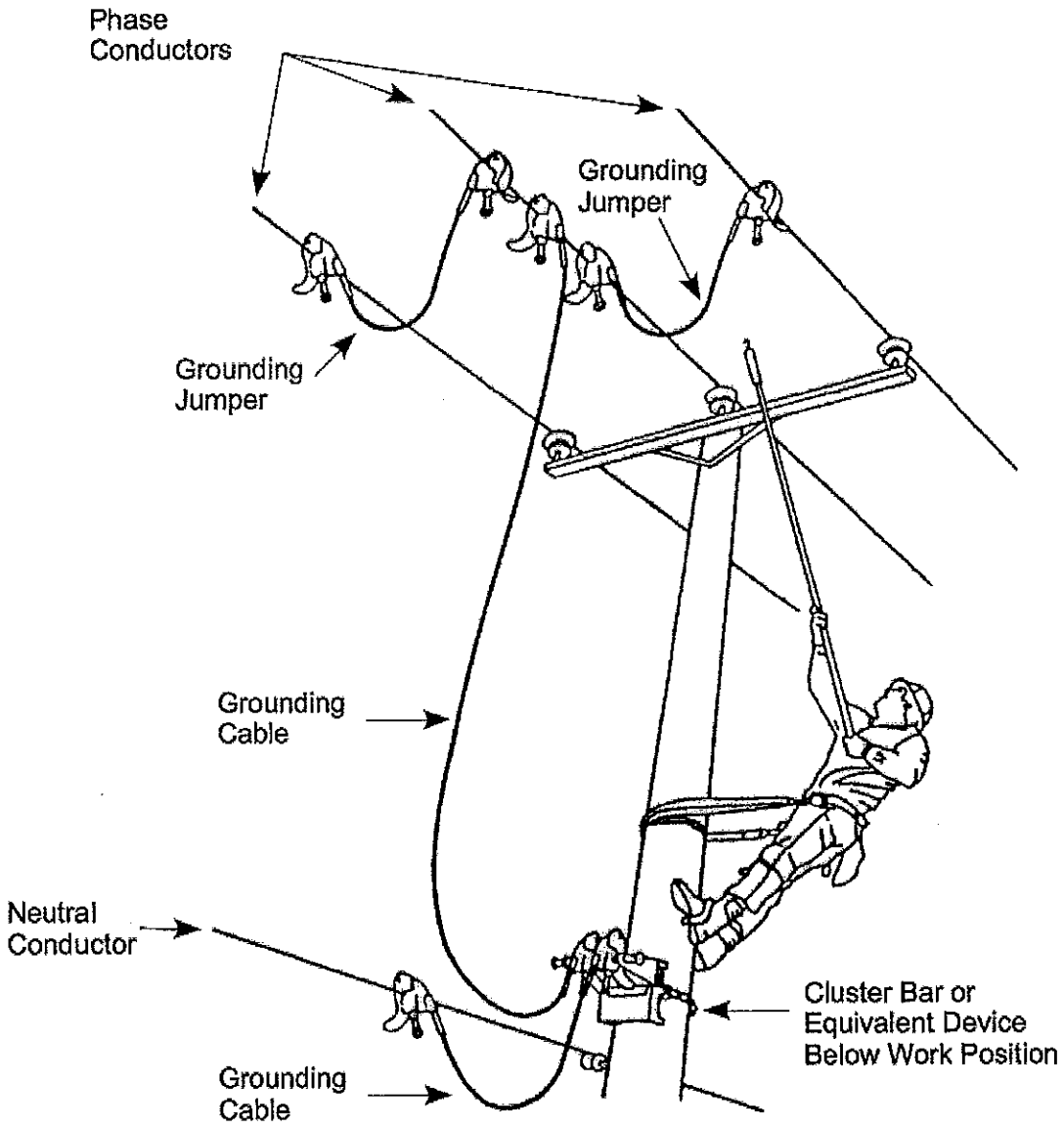


Figure 5—Equipotential Grounding for Wood Poles

Figure reprinted with permission from Hubbell Power Systems, Inc. (Hubbell).

OSHA revised the figure from Hubbell's original.

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For underground systems, employers commonly install grounds at the points of disconnection of the underground cables. These grounding points are typically remote from the manhole or underground vault where employees will be working on the cable. Workers in contact with a cable grounded at a remote location can experience hazardous potential differences if the cable becomes energized or if a fault occurs on a different, but nearby, energized cable. The fault current causes potential gradients in the earth, and a potential difference will exist between the earth where the worker is standing and the earth where the cable is grounded. Consequently, to create an equipotential zone for the worker, the employer 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]

[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

Continued

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.

Appendix D to Subpart V of Part 1926—Methods of Inspecting and Testing Wood Poles

I. Introduction

When employees are to perform work on a wood pole, it is important to determine the condition of the pole before employees climb it. The weight of the employee, the weight of equipment to be installed, and other working stresses (such as the removal or retensioning of conductors) can lead to the failure of a defective pole or a pole that is not designed to handle the additional stresses.[1] For these reasons, it is essential that, before an employee climbs a wood pole, the employer ascertain that the pole is capable of sustaining the stresses of the work. The determination that the pole is capable of sustaining these stresses includes an inspection of the condition of the pole.

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

II. Inspecting Wood Poles

A qualified employee should inspect wood poles for the following conditions:[2]

A. *General condition.* Buckling at the ground line or an unusual angle with respect to the ground may indicate that the pole has rotted or is broken.

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

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

D. *Shell rot and decay.* Rotting and decay are cutout hazards and possible indications of the age and internal condition of the pole.

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

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

G. *Soil conditions.* Soft, wet, or loose soil around the base of the pole may indicate that the pole will not support any change in stress.

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

III. Testing Wood Poles

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

Appendix E to Subpart V of Part 1926—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).

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

guidelines for selecting and installing grounding equipment that will meet § 1926.962(d)(1)(i).

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

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

[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.*)

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 ASSESSMENTS FOR VARIOUS TASKS

Task		Is employee exposed to flame or electric-arc hazard?
Normal operation of enclosed equipment, such as closing or opening a switch.	The employer properly installs and maintains enclosed equipment, and there is no evidence of impending failure.	No.
	There is evidence of arcing or overheating	Yes.
	Parts of the equipment are loose or sticking, or the equipment otherwise exhibits signs of lack of maintenance.	Yes.
Servicing electric equipment, such as racking in a circuit breaker or replacing a switch		Yes.
Inspection of electric equipment with exposed 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 approximatelyinversely 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]

TABLE 3—SELECTING A REASONABLE INCIDENT-ENERGY CALCULATION METHOD [1]—Continued

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
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) (MAD – (2×*kV*/10)) †	NA

* NA = not applicable.
† The terms in this equation are:
MAD = The applicable minimum approach distance, and
kV = The system voltage in kilovolts.

Selecting a reasonable arc gap. For a single-phase arc in air, the electric arc will almost always occur when an energized conductor approaches too close to ground. Thus, an employer can determine the arc gap, or arc length, for these exposures by the dielectric strength of air and the voltage on the line. The dielectric strength of air is approximately 10 kilovolts for every 25.4 millimeters (1 inch). For example, at 50 kilovolts, the arc gap would be 50 ÷ 10 × 25.4 (or 50 × 2.54), which equals 127 millimeters (5 inches).

For three-phase arcs in open air and in enclosures, the arc gap will generally be dependent on the spacing between parts energized at different electrical potentials. Documents such as IEEE Std 1584b–2011 provide information on these distances. Employers may select a reasonable arc gap from Table 5, or they may select any other reasonable arc gap based on sparkover distance or on the spacing between (1) live parts at different potentials or (2) live parts and grounded parts (for example, bus or conductor spacings in equipment). In any event, the employer must use an estimate that reasonably resembles the actual exposures faced by the employee.

TABLE 5—SELECTING A REASONABLE ARC GAP

Class of equipment	Single-phase arc mm (inches)	Three-phase arc mm [1] (inches)
Cable	NA [2]	13 (0.5)
Low voltage MCCs and panelboards	NA	25 (1.0)
Low-voltage switchgear	NA	32 (1.25)
5-kV switchgear	NA	104 (4.0)
15-kV switchgear	NA	152 (6.0)
Single conductors in air, 15 kV and less	51 (2.0)	Phase conductor spacings.

TABLE 5—SELECTING A REASONABLE ARC GAP—Continued

Class of equipment	Single-phase arc mm (inches)	Three-phase arc mm [1] (inches)
Single conductor in air, more than 15 kV	Voltage in kV × 2.54 (Voltage in kV × 0.1), but no less than 51 mm (2 inches)	Phase conductor spacings.

[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/cm²) from the table. For example, an employer might have a 12,470-volt power line supplying a system area. The power line can supply a maximum fault current of 8 kiloamperes with a maximum clearing time of 10 cycles. For rubber glove work, this system falls in the 4.0-to-15.0-kilovolt range; the next-higher fault current is 10 kA (the second row in that voltage range); and the clearing time is under 18 cycles (the first column to the right of the fault current column). Thus, the available heat energy for this part of the system will be 4 cal/cm² or less (from the column heading), and the employer could select protection with a 5-cal/cm² rating to meet § 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/cm² can use the table to determine if any system area exceeds 8 cal/cm² by checking the clearing time for the highest fault current for each voltage range and ensuring that the clearing times do not exceed the values specified in the 8-cal/cm² column in the table.

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

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

TABLE 6—INCIDENT HEAT ENERGY FOR VARIOUS FAULT CURRENTS, CLEARING TIMES, AND VOLTAGES OF 4.0 TO 46.0 KV: RUBBER INSULATING GLOVE EXPOSURES INVOLVING PHASE-TO-GROUND ARCS IN OPEN AIR ONLY* † ‡

Voltage range (kV)**	Fault current (kA)	Maximum clearing time (cycles)			
		4 cal/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).

[2] The Occupational Safety and Health Administration used metric values to calculate the clearing times in Table 6 and Table 7. An employer may use English units to calculate clearing times instead even though the results will differ slightly.

[3] The Occupational Safety and Health Administration based this assumption, which is more conservative than the arc length specified in Table 5, on Table 410–2 of the 2012 NESC.

[4] The dielectric strength of air is about 10 kilovolts for every 25.4 millimeters (1 inch). Thus, the employer can estimate the arc length in millimeters to be the phase-to-ground voltage in kilovolts multiplied by 2.54 (or voltage (in kilovolts) × 2.54).

† 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/cm²	5 cal/cm²	8 cal/cm²	12 cal/cm²
4.0 to 15.0	5	197	246	394	591
	10	73	92	147	220
	15	39	49	78	117
	20	24	31	49	73
15.1 to 25.0	5	197	246	394	591
	10	75	94	150	225
	15	41	51	82	122
	20	26	33	52	78
25.1 to 36.0	5	138	172	275	413
	10	53	66	106	159
	15	30	37	59	89
	20	19	24	38	58
36.1 to 46.0	5	129	161	257	386
	10	51	64	102	154
	15	29	36	58	87
	20	19	24	38	57
46.1 to 72.5	20	18	23	36	55
	30	10	13	20	30
	40	6	8	13	19
	50	4	6	9	13
72.6 to 121.0	20	10	12	20	30
	30	6	7	11	17
	40	4	5	7	11
	50	3	3	5	8
121.1 to 145.0	20	12	15	24	35
	30	7	9	15	22
	40	5	6	10	15
	50	4	5	8	11
145.1 to 169.0	20	12	15	24	36
	30	7	9	15	22
	40	5	7	10	16
	50	4	5	8	12
169.1 to 242.0	20	13	17	27	40
	30	8	10	17	25
	40	6	7	12	17
	50	4	5	9	13
242.1 to 362.0	20	25	32	51	76
	30	16	19	31	47
	40	11	14	22	33
	50	8	10	16	25
362.1 to 420.0	20	12	15	25	37
	30	8	10	15	23
	40	5	7	11	16
	50	4	5	8	12
420.1 to 550.0	20	23	29	47	70
	30	14	18	29	43
	40	10	13	20	30
	50	8	9	15	23
550.1 to 800.0	20	25	31	50	75
	30	15	19	31	46
	40	11	13	21	32
	50	8	10	16	24

Notes:

* This table is for open-air, phase-to-ground electric-arc exposures. It is not for phase-to-phase arcs or enclosed arcs (arc in a box).

† The table assumes the arc length to be the sparkover distance for the maximum phase-to-ground voltage of each voltage range (see Appendix B to 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.

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 kV 1.72 m
242.1 to 362.0 kV 2.76 m
362.1 to 420.0 kV 2.50 m
420.1 to 550.0 kV 3.62 m
550.1 to 800.0 kV 4.83 m
**The voltage range is the phase-to-phase system voltage.

B. Selecting Protective Clothing and Other Protective Equipment

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.

Paragraph (g)(5) of § 1926.960 does not require arc-rated protection for exposures of 2 cal/cm² or less. Untreated cotton clothing will reduce a 2-cal/cm² exposure below the 1.2- to 1.5-cal/cm² level necessary to cause burn injury, and this material should not ignite at such low heat energy levels. Although § 1926.960(g)(5) does not require clothing to have an arc rating when exposures are 2 cal/cm² 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/cm², as discussed later in this appendix. Additionally, it is especially important to ensure that employees do not wear undergarments made from fabrics listed in the note to § 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/cm². When the employee is wearing heavy-duty leather work gloves with a weight of at least 407 gm/m² (12 oz/yd²)

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:

Exposure	Minimum head and face protection		
	None*	Arc-rated faceshield with a minimum rating of 8 cal/cm²*	Arc-rated hood or faceshield with balaclava
Single-phase, open air	2–8 cal/cm²	9–12 cal/cm²	13 cal/² or higher.†
Three-phase	2–4 cal/cm²	5–8 cal/cm²	9 cal/cm² 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/cm² 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/cm² 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/cm² or less.[6] If the exposure is greater than that, the employee generally must wear

[5] ASTM F1506–10a defines "arc thermal performance value" as "the incident energy on a material or a multilayer system of materials that results in a 50% probability that sufficient heat transfer through the tested specimen is predicted to cause the onset of a second-degree skin burn injury based on the Stoll [footnote] curve, cal/cm²." The footnote to this definition reads: "Derived from: Stoll, A.M., and Chianta, M.A., 'Method and Rating System for Evaluations of Thermal Protection,' Aerospace Medicine, Vol 40, 1969, pp. 1232–1238 and Stoll A.M., and Chianta, M.A., 'Heat Transfer through Fabrics as Related to Thermal Injury,' Transactions—New York Academy of Sciences, Vol 33(7), Nov. 1971, pp. 649–670."

[6] See § 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/cm².

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.

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).

Appendix F to Subpart V of Part 1926—Work-Positioning Equipment Inspection Guidelines

I. Body Belts

Inspect body belts to ensure that:

A. The hardware has no cracks, nicks, distortion, or corrosion;

B. No loose or worn rivets are present;

C. The waist strap has no loose grommets;

D. The fastening straps are not 100-percent leather; and

E. No worn materials that could affect the safety of the user are present.

II. Positioning Straps

Inspect positioning straps to ensure that:

A. The warning center of the strap material is not exposed;

B. No cuts, burns, extra holes, or fraying of strap material is present;

C. Rivets are properly secured;

D. Straps are not 100-percent leather; and

E. Snaphooks do not have cracks, burns, or corrosion.

III. Climbers

Inspect pole and tree climbers to ensure that:

A. Gaffs are at least as long as the manufacturer's recommended minimums (generally 32 and 51 millimeters (1.25 and 2.0 inches) for pole and tree climbers, respectively, measured on the underside of the gaff);

Note: Gauges are available to assist in determining whether gaffs are long enough and shaped to easily penetrate poles or trees.

B. Gaffs and leg irons are not fractured or cracked;

C. Stirrups and leg irons are free of excessive wear;

D. Gaffs are not loose;

E. Gaffs are free of deformation that could adversely affect use;

F. Gaffs are properly sharpened; and

G. There are no broken straps or buckles.

Appendix G to Subpart V of Part 1926—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.

ANSI/SIA A92.2–2009, *American National Standard for Vehicle-Mounted Elevating and Rotating Aerial Devices.*

ANSI Z133–2012, *American National Standard Safety Requirements for Arboricultural Operations—Pruning, Trimming, Repairing, Maintaining, and Removing Trees, and Cutting Brush.*

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

ASME B20.1–2012, *Safety Standard for Conveyors and Related Equipment.*

ASTM D120–09, *Standard Specification for Rubber Insulating Gloves.*

ASTM D149–09 (2013), *Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies.*

ASTM D178–01 (2010), *Standard Specification for Rubber Insulating Matting.*

ASTM D1048–12, *Standard Specification for Rubber Insulating Blankets.*

ASTM D1049–98 (2010), *Standard Specification for Rubber Insulating Covers.*

ASTM D1050–05 (2011), *Standard Specification for Rubber Insulating Line Hose.*

ASTM D1051–08, *Standard Specification for Rubber Insulating Sleeves.*

ASTM F478–09, *Standard Specification for In-Service Care of Insulating Line Hose and Covers.*

ASTM F479–06 (2011), *Standard Specification for In-Service Care of Insulating Blankets.*

ASTM F496–08, *Standard Specification for In-Service Care of Insulating Gloves and Sleeves.*

ASTM F711–02 (2007), *Standard Specification for Fiberglass-Reinforced Plastic (FRP) Rod and Tube Used in Live Line Tools.*

ASTM F712–06 (2011), *Standard Test Methods and Specifications for Electrically Insulating Plastic Guard Equipment for Protection of Workers.*

ASTM F819–10, *Standard Terminology Relating to Electrical Protective Equipment for Workers.*

ASTM F855–09, *Standard Specifications for Temporary Protective Grounds to Be Used on De-energized Electric Power Lines and Equipment.*

ASTM F887–12^{e1}, *Standard Specifications for Personal Climbing Equipment.*

ASTM F914/F914M–10, *Standard Test Method for Acoustic Emission for Aerial Personnel Devices Without Supplemental Load Handling Attachments.*

ASTM F1116–03 (2008), *Standard Test Method for Determining Dielectric Strength of Dielectric Footwear.*

ASTM F1117–03 (2008), *Standard Specification for Dielectric Footwear.*

ASTM F1236–96 (2012), *Standard Guide for Visual Inspection of Electrical Protective Rubber Products.*

ASTM F1430/F1430M–10, *Standard Test Method for Acoustic Emission Testing of Insulated and Non-Insulated Aerial Personnel Devices with Supplemental Load Handling Attachments.*

ASTM F1505–10, *Standard Specification for Insulated and Insulating Hand Tools.*

ASTM F1506–10a, *Standard Performance Specification for Flame Resistant and Arc Rated Textile Materials for Wearing Apparel for Use by Electrical Workers Exposed to Momentary Electric Arc and Related Thermal Hazards.*

ASTM F1564–13, *Standard Specification for Structure-Mounted Insulating Work Platforms for Electrical Workers.*

ASTM F1701–12, *Standard Specification for Unused Polypropylene Rope with Special Electrical Properties.*

ASTM F1742–03 (2011), *Standard Specification for PVC Insulating Sheeting.*

[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.

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.*
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.*

Subpart X—Stairways and Ladders

■ 18. Revise the authority citation for Subpart X of part 1926 to read as follows:

Authority: 40 U.S.C. 3701 *et seq.;* 29 U.S.C. 653, 655, 657; Secretary of Labor's Order No. 1–90 (55 FR 9033), 5–2007 (72 FR 31159), or 1–2012 (77 FR 3912), as applicable; and 29 CFR Part 1911.

■ 19. Revise § 1926.1053(b)(12) to read as follows:

§ 1926.1053 Ladders.

* * * * *

(b) * * *

(12) Ladders shall have nonconductive siderails if they are used where the employee or the ladder could contact exposed energized electrical equipment, except as provided in § 1926.955(b) and (c) of this part.

Subpart CC—Cranes and Derricks in Construction

■ 20. Revise the authority citation for Subpart CC of Part 1926 to read as follows:

Authority: 40 U.S.C. 3701 *et seq.;* 29 U.S.C. 653, 655, 657; Secretary of Labor's Order No. 5–2007 (72 FR 31159) or 1–2012 (77 FR 3912), as applicable; and 29 CFR Part 1911.

■ 21. Revise paragraph (g) of § 1926.1400 to read as follows:

§ 1926.1400 Scope.

* * * * *

(g) For work covered by Subpart V of this part, compliance with § 1926.959 is deemed compliance with §§ 1926.1407 through 1926.1411.

* * * * *

■ 22. In § 1926.1410, remove and reserve paragraph (d)(4)(iii) and revise paragraphs (c)(2) and (d)(4)(ii) to read as follows:

§ 1926.1410 Power line safety (all voltages)—equipment operations closer than the Table A zone.

* * * * *

(c) * * *

(2) Paragraph (c)(1) of this section does not apply to work covered by Subpart V of this part; instead, for such work, the minimum approach distances established by the employer under § 1926.960(c)(1)(i) apply.

* * * * *

(d) * * *

(4) * * *

(ii) Paragraph (d)(4)(i) of this section does not apply to work covered by Subpart V of this part.

(iii) [Removed and Reserved]

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[FR Doc. 2013–29579 Filed 4–1–14; 11:15 am]
BILLING CODE 4510–26–P