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29 CFR Part 1910
Electrical Standard; Final Rule

DEPARTMENT OF LABOR

Occupational Safety and Health Administration

29 CFR Part 1910

[Docket No. S–108C]

RIN 1218–AB95

Electrical Standard

AGENCY: Occupational Safety and Health Administration, Labor.

ACTION: Final rule.

SUMMARY: The Occupational Safety and Health Administration (OSHA) is revising the general industry electrical installation standard found in Subpart S of 29 CFR Part 1910. The Agency has determined that electrical hazards in the workplace pose a significant risk of injury or death to employees, and that the requirements in the revised standard, which draw heavily from the 2000 edition of the National Fire Protection Association's (NFPA) Electrical Safety Requirements for Employee Workplaces (NFPA 70E), and the 2002 edition of the National Electrical Code (NEC), are reasonably necessary to provide protection from these hazards. This final rule focuses on safety in the design and installation of electric equipment in the workplace. This revision will provide the first update of the installation requirements in the general industry electrical installation standard since 1981.

OSHA is also replacing the reference to the 1971 NEC in the mandatory appendix to the general industry powered platform standard found in Subpart F of 29 CFR Part 1910 with a reference to OSHA's electrical installation standard.

DATES: This final rule becomes effective on August 13, 2007.

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: For general information and press inquiries, contact Mr. Kevin Ropp, Director, Office of Communications, Room N–3647, OSHA, U.S. Department of Labor, 200 Constitution Avenue, NW., Washington, DC 20210; telephone (202) 693–1999. For technical inquiries, contact Mr. David Wallis, Directorate of Standards and Guidance, Room N–3609, OSHA, U.S. Department of Labor, 200 Constitution Avenue, NW., Washington, DC 20210; telephone (202) 693–2222.

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SUPPLEMENTARY INFORMATION:

I. Introduction

This final rule revises OSHA's existing standard for electrical installations, which is contained in §§ 1910.302 through 1910.308 of Subpart S, with relevant definitions in § 1910.399. It applies, as the existing standard does, to employers in general industry and in shipyard employment, longshoring, and marine terminals.

OSHA undertook the project to revise Subpart S for two major reasons. First, the Agency wanted the standard to reflect the most current practice and technology in the industry. The existing standard is based on a national consensus standard, the 1979 edition of Part I of NFPA 70E, entitled Standard for Electrical Safety Requirements for Employee Workplaces. That consensus standard has been updated several times since OSHA last revised its electrical installation requirements in 1981. The final rule being published today is based on Part I of the 2000 edition of NFPA 70E. Second, in implementing this rule, OSHA is responding to requests from stakeholders that the Agency revise Subpart S so that it reflects the most recent editions of NFPA 70E and the NEC.[1] These stakeholders argued that interested members of the public have had substantial input into the content of NFPA 70E and that industry is complying with that consensus standard in its present form. The revised standard will be more flexible and efficient for stakeholders, including small businesses, while improving safety for employees.

OSHA's existing electrical standard in §§ 1910.302 through 1910.308 is based on the 1979 edition of NFPA 70E, which is a national consensus standard developed by a cross section of industry, labor, and other allied interests. Consensus standards like the NEC and NFPA 70E provide nationally recognized safe electrical installation requirements. Additionally, the consensus process used in developing the 2000 edition of NFPA 70E, Part 1 of which is based on the NEC, ensures that requirements contained in that standard are current and at the forefront of electrical safety technology. Because the primary objective of this revision of Subpart S is to update the standard to recognize, and in some cases require, the more current electrical safety technology, OSHA believes that the more recent editions of NFPA 70E should be the foundation of the final standard.[2] Lastly, the Agency has determined that electrical hazards in general industry workplaces pose a significant risk and that the final standard will substantially reduce that risk.

The remainder of the preamble discusses the background of the final rule, the history of the standard, and the legal authority for the standard; provides a summary and explanation of the final standard; includes the final economic and regulatory flexibility analysis and the information collections associated with the rule; and covers other miscellaneous topics. The outline of the preamble is as follows:

II. Background

A. Hazards Associated With Electricity

Electricity is widely recognized as a serious workplace hazard, exposing employees to electric shock, burns, fires, and explosions. According to the Bureau of Labor Statistics, 289 employees were killed by contact with electric current in 2002 (Ex. 2–8). Other employees have been killed or injured

[1] See, for example, letters from: Judith Gorman, Managing Director of the Institute of Electrical and Electronic Engineers; George D. Miller, President and Chief Executive Officer of the National Fire Protection Association; Frank K. Kitzantides, Vice President of Engineering at the National Electrical Manufacturers Association; and Kari P. Barrett, Director of Regulatory and Technical Affairs, Plant Operations, at the American Chemistry Council (Exhibit 2–62, 2–63, 2–64, 2–65).

[2] A newer edition of NFPA 70E was published shortly after OSHA issued the proposed rule. Whether the final rule should be based on this edition, NFPA 70E–2004, is one of the issues raised by comments on the proposal. See the discussion of this issue in section V, Summary and Explanation of the Final Standard.

in fires and explosions caused by electricity.

It is well known that the human body will conduct electricity. If direct body contact is made with an electrically energized part while a similar contact is made simultaneously with another conductive surface that is maintained at a different electrical potential, a current will flow, entering the body at one contact point, traversing the body, and then exiting at the other contact point, usually the ground. Each year many employees suffer pain, injuries, and death from such electric shocks.

Current through the body, even at levels as low as 3 milliamperes, can also cause injuries of an indirect or secondary nature in which involuntary muscular reaction from the electric shock can cause bruises, bone fractures and even death resulting from collisions or falls.

Burns suffered in electrical accidents can be very serious. These burns may be of three basic types: electrical burns, arc burns, and thermal contact burns. Electrical burns are the result of the electric current flowing in the tissues, and may be either skin deep or may affect deeper layers (such as muscles and bones) or both. Tissue damage is caused by the heat generated from the current flow; if the energy delivered by the electric shock is high, the body cannot dissipate the heat, and the tissue is burned. Typically, such electrical burns are slow to heal. Arc burns are the result of high temperatures produced by electric arcs or by explosions close to the body. Finally, thermal contact burns are those normally experienced from the skin contacting hot surfaces of overheated electric conductors, conduits, or other energized equipment. In some circumstances, all three types of burns may be produced simultaneously.

If the current involved is great enough, electric arcs can start a fire. Fires can also be created by overheating equipment or by conductors carrying too much current. Extremely high-energy arcs can damage equipment, causing fragmented metal to fly in all directions. In atmospheres that contain explosive gases or vapors or combustible dusts, even low-energy arcs can cause violent explosions.

B. Nature of Electrical Accidents

Electrical accidents, when initially studied, often appear to be caused by circumstances that are varied and peculiar to the particular incidents involved. However, further consideration usually reveals the underlying cause to be a combination of three possible factors: work involving unsafe equipment and installations; workplaces made unsafe by the environment; and unsafe work performance (unsafe acts). The first two factors are sometimes considered together and simply referred to as unsafe conditions. Thus, electrical accidents can be generally considered as being caused by unsafe conditions, unsafe acts, or, in what is usually the case, combinations of the two. It should also be noted that inadequate maintenance can cause equipment or installations that were originally considered safe to deteriorate, resulting in an unsafe condition.

Some unsafe electric equipment and installations can be identified, for example, by the presence of faulty insulation, improper grounding, loose connections, defective parts, ground faults in equipment, unguarded live parts, and underrated equipment. The environment can also be a contributory factor to electrical accidents in a number of ways. Environments containing flammable vapors, liquids, or gases; areas containing corrosive atmospheres; and wet and damp locations are some unsafe environments affecting electrical safety. Finally, unsafe acts include the failure to deenergize electric equipment when it is being repaired or inspected or the use of tools or equipment too close to energized parts.

C. Protective Measures

There are various ways of protecting employees from the hazards of electric shock, including insulation and guarding of live parts. Insulation provides a barrier to the flow of current. To be effective, the insulation must be appropriate for the voltage, and the insulating material must be undamaged, clean, and dry. Guarding prevents the employee from coming too close to energized parts. It can be in the form of a physical barricade, or it can be provided by installing the live parts out of employees' reach. (This technique is known as ''guarding by location.'')

Grounding is another method of protecting employees from electric shock; however, it is normally a secondary protective measure. To keep guards or enclosures at a common potential with earth, they are connected, by means of a grounding conductor, to ground. In addition, grounding provides a path of low impedance and of ample capacity back to the source to pass enough current to activate the overcurrent devices in the circuit. If a live part accidentally contacts a grounded enclosure, current flow is directed back to earth, and the circuit protective devices (for example, fuses and circuit breakers) can interrupt the circuit.

If it draws too much current, electric equipment can overheat, which can result in fires. Overheating can also lead to electric shock hazards if the insulation protecting a conductor melts. Protecting electric equipment from overcurrent helps prevent this from happening.

Designing and installing equipment to protect against dangerous arcing and overheating is also important in preventing unsafe conditions that can lead to fires, high energy electric arcs, and explosions. Employers and employees cannot usually detect improperly designed or rated equipment. Thus, OSHA relies on third-party testing and certification of electric equipment to ensure proper electrical design. This helps ensure, for example, that equipment will not overheat during normal operation and that equipment designed for use in a hazardous location will not cause a fire or explosion. It also helps ensure that equipment is appropriately rated and marked, allowing employees designing electrical installations and installing electric equipment to select equipment and size conductors in accordance with those ratings.[3] Many of the requirements in OSHA's electrical standards in turn depend on accurate ratings on equipment.

These protective measures help ensure the safe installation of electric equipment and are prescribed by the requirements presently contained in 29 CFR Part 1910, Subpart S. Addressing common unsafe conditions, these rules cover such safety considerations as guarding and insulation of live parts, grounding of equipment enclosures, and protection of circuits from overcurrent. This rulemaking updates those requirements to make them consistent with the latest editions of NFPA 70E. This revision will better protect employees by recognizing the latest techniques in electrical safety and by requiring installations to incorporate those techniques whenever necessary.

[3] Electric equipment is typically rated for use with certain voltages and current. For example, an electric hair dryer might be rated at 125 volts, 1875 watts. The voltage rating indicates the maximum voltage for which the equipment is rated. The wattage rating indicates how much power the equipment will draw when connected to a circuit at the maximum voltage. The current drawn by the equipment is the wattage rating divided by the voltage rating. Thus, the circuit voltage (120 volts, nominal) is less than the maximum rated voltage of the hair dryer (125 volts), and the circuit is rated for the current the equipment will draw (1875 watts/125 volts = 15 amperes). Thus, the hair dryer would be suitable for use on a 120-volt circuit capable of safely carrying 15 amperes.

D. Significant Risk and Reduction in Risk

As stated earlier, electricity has long been recognized as a serious workplace hazard exposing employees to dangers such as electric shock, electrocution, fires, and explosions. The 100-year-long history of the National Electrical Code, originally formulated and periodically updated by industry consensus, attests to this fact. The NEC has represented the continuing efforts of experts in electrical safety to address these hazards and provide standards for limiting exposure in all electrical installations, including workplaces. OSHA has determined that electrical hazards in the workplace pose a significant risk of injury or death to employees and that this final rule, which draws heavily on the experience of the NEC, will substantially reduce this risk.

According to the U.S. Bureau of Labor Statistics, between 1992 and 2002, an average of 295 employees died per year from contact with electric current, and between 1992 and 2001 an average of 4,309 employees lost time away from work because of electrical injuries.[4] Overall, there has been a downward trend in injuries and illnesses, but the percentage has varied from year to year. From 1992 to 2001, the number of injuries involving days away from work decreased by 29 percent. From 1992 to 2002, the number of deaths decreased by 9 percent. This downward trend is due, in major part, to 30 years of highly protective OSHA regulation in the area of electrical installation, based on the NEC and NFPA 70E standards. The final standard carries forward most of the existing requirements for electrical installations, with the new and revised requirements intended as fine tuning, introducing new technology along with other improvements in safety. By complying with the final standard, employers will prevent unsafe electrical conditions from occurring.

While the number of deaths and injuries associated with electrical hazards has declined, contact with electric current still poses a significant risk to employees in the workplace, as evidenced by the numbers of deaths and serious injuries still occurring due to contact with electric current. This final rule will help further reduce the number of deaths and injuries associated with electrical hazards by providing additional requirements for installation safety and by recognizing alternative means of compliance.

[4] The Survey of Occupational Injuries and Illnesses and the Census of Fatal Occupational Injuries, *http://www.bls.gov/iif/home.htm#tables.*

III. History of the Standard

On February 16, 1972, OSHA incorporated the 1971 edition of the National Fire Protection Association's (NFPA) National Electrical Code (NEC), NFPA 70–1971, by reference as its electrical standard for general industry (37 FR 3431). The Agency followed the procedures outlined in Section 6(a) of the Occupational Safety and Health Act of 1970 (OSH Act; 29 U.S.C. 655), which directed the Secretary to adopt existing national consensus standards as OSHA standards within 2 years of the effective date of the OSH Act. In incorporating the 1971 NEC by reference, OSHA made the entire 1971 NEC applicable to all covered electrical installations made after March 15, 1972. For covered installations made before that date, OSHA listed about 16 provisions from the 1971 NEC that applied. No other provisions of the 1971 NEC applied to these older installations. Thus, older installations were ''grandfathered'' so that they did not need to meet most of the requirements in the consensus standard.

On January 16, 1981, OSHA revised its electrical installation standard for general industry (46 FR 4034). This revision replaced the incorporation by reference of the 1971 NEC with relevant requirements from Part I of the 1979 edition of NFPA 70E. The revision simplified and clarified the electrical standard and updated its provisions to match the 1978 NEC (the latest edition available at the time). The standard was written to reduce the need for frequent revision and to avoid technological obsolescence. These goals were achieved—NFPA 70E had only minor changes over its initial 15 years of existence. The first substantial changes were introduced in the 1995 edition of NFPA 70E.

The 2000 edition of NFPA 70E contains a number of significant revisions, including a new, alternative method for classifying and installing equipment in Class I hazardous locations (see preamble Section I. N. Zone Classification, below). NFPA has recommended that OSHA revise its general industry electrical standards to reflect the latest edition of NFPA 70E, arguing that such a revision would provide a needed update to the OSHA standards and would better protect employees. This final rule responds to NFPA's recommendations with regard to installation safety. It also reflects the Agency's commitment to update its electrical standards, keep them consistent with NFPA standards, and ensure that they appropriately protect employees. The Agency intends to extend this commitment by using NFPA 70E as a basis for future revisions to its electrical safety-related work practice requirements and new requirements for electrical maintenance and special equipment.

The proposed rule was published in the **Federal Register** on April 5, 2004. The public had a 60-day comment period that ended on June 4, 2004. OSHA received 38 comments on the proposed revision of OSHA's electrical installation standard for general industry. The Agency received one hearing request on the proposal, which was subsequently withdrawn.

The comments addressed specific provisions in the proposal and raised several issues, including: (1) Whether OSHA should use the latest edition of NFPA 70E or the NEC to revise Subpart S; (2) whether OSHA should update the corresponding construction standard at the same time; (3) whether OSHA should address work practices and other revised provisions of NFPA 70E; and (4) what the effective date of the standard should be. (See section V, ''Summary and Explanation of the Final Standard,'' later in the preamble, for a discussion of the comments.)

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. 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 standard is reasonably necessary or appropriate within the meaning of Section 652(8) if:

- A significant risk of material harm exists in the workplace and the proposed standard would substantially reduce or eliminate that workplace risk;
- It is technologically and economically feasible;
- It employs the most cost effective protective measures;
- It is consistent with prior Agency action or supported by a reasoned justification for departing from prior Agency action;
- It is supported by substantial evidence; and

• In the event the standard is preceded by a consensus standard, it is better able to effectuate the purposes of the OSH Act than the standard it supersedes.

International Union, UAW v. *OSHA (LOTO II),* 37 F.3d 665, 668 (D.C. Cir. 1994).

OSHA has generally considered an excess risk of 1 death per 1000 employees over a 45-year working lifetime as clearly representing a significant risk (see *Industrial Union Dept.* v. *American Petroleum Institute (Benzene),* 448 U.S. 607, 655 (1980); *International Union* v. *Pendergrass (Formaldehyde),* 878 F.2d 389, 392–93 (D.C. Cir. 1989); *Building and Construction Trades Dept., AFL–CIO* v. *Brock (Asbestos),* 838 F.2d 1258, 1264–65 (D.C. Cir. 1988)).

A standard is considered 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 *American Iron and Steel Institute* v. *OSHA (Lead II),* 939 F.2d 975, 980 (D.C. Cir. 1991)). A standard is economically feasible when industry can absorb or pass on the costs of compliance without threatening the industry's long-term profitability or competitive structure (see *American Textile Mfrs. Institute* v. *OSHA (Cotton Dust),* 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 LOTO II, 37 F.3d at 668).

All OSHA standards must be highly protective (LOTO II, 37 F.3d at 669) and, where practical, ''expressed in terms of objective criteria and of the performance desired.'' 29 U.S.C. 655(b)(5). 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 purpose of the OSH Act. 29 U.S.C. 655(b)(8). As discussed earlier, OSHA is using NFPA 70E as the basis for its final rule, with some modifications as necessary, as explained in detail in the next section of the preamble.

V. Summary and Explanation of the Final Standard

This section discusses the important elements of the final standard, explains the purpose of the individual requirements, and explains any differences between the final standard and the existing standard. This section also discusses and resolves issues raised during the comment period, significant comments received as part of the rulemaking record, and any substantive changes that were made from the language of the proposed rule. References in parentheses are to exhibits in the rulemaking record. Except as noted, OSHA is carrying forward the language from the proposal into the final rule without substantive differences.

A. Issues

1. *Comments supporting the revision of Subpart S.* The vast majority of the comments supported OSHA's efforts to update the general industry electrical standards (Exs. 3–3, 3–4, 3–6, 3–7, 3–8, 3–9, 4–10, 4–24). For example, the National Petrochemical & Refiners Association expressed support for updating Subpart S so that it is consistent with the current editions of the NFPA 70E and the NEC, because, they stated, its members place a high priority on safety and understand the necessity for electrical installation standards (Ex. 3–4). The American Society of Safety Engineers (ASSE) also supported the proposal, stating: ''It is appropriate to move forward with this revision, given the seriousness of electrical hazards and the fact that nearly 300 workers are killed each year from contact with electrical current or as the result of injuries caused by fires and explosions related to electrical accidents [Ex. 3–5].''

The National Institute for Occupational Safety and Health (NIOSH) and the North Carolina Department of Labor also supported OSHA's proposed revision (Exs. 3–9, 5–2). NIOSH stated: ''The proposed revised standard will provide workers in general industry and maritime employment with improved protection against injuries and death from electrical hazards [Ex. 3–9].'' The North Carolina Department of Labor expressed a similar view, stating: ''The revisions proposed to the existing standard should provide a greater measure of protection to employees working on and around electrical equipment and installations [Ex. 5–2].''

OSHA appreciates the support of these commenters. The Agency believes that the final standard will better protect employees than the existing standard. The record overwhelmingly supports this view.

2. *OSHA should use the latest version of NFPA 70E or the NEC.* OSHA received several comments recommending that the standard be based on the latest version of NFPA 70E or the NEC (Exs. 3–8, 4–3, 4–6, 4–8, 4–11). Some of the commenters argued that, by using the 2000 edition of the NFPA 70E rather than the more recent 2004 edition, OSHA was not reflecting the most current practices and technology. For example, David Soffrin of the American Petroleum Institute stated:

> We applaud the reasons for the proposal, as stated by OSHA: (a) To reflect the most current practice and technology in the industry; and (b) to respond to requests from stakeholders that the electrical standards conform with the most recent editions of the National Fire Protection Association (NFPA) 70E, Standard for Electrical Safety Requirements for Employee Workplaces, and the National Electrical Code (NEC). However, the proposal follows the NFPA standard 70E–2000, while the NFPA Standards Council issued an updated version January 14, 2004, which supercedes NFPA 70E–2000. We believe that if the intent is to reflect the most current practice and technology, using a four-year-old standard, which will be even more dated by the time OSHA finalizes this standard, is inappropriate. We therefore recommend that OSHA revise the proposal using NFPA 70E–2004, Standard for Electrical Safety in the Workplace, or the 2002 NEC, which would require numerous modifications [Ex. 4–11].

John Paschal of the Bechtel Corporation wrote: ''Since NFPA 70E–2004 is now published and issued to the public, and since it contains significantly enhanced technical data that the NFPA 70E–2000 did not contain, I recommend that OSHA adopt NFPA 70E–2004 instead of NFPA 70E–2000 [Ex. 4–3].''

James Kendrick of ASSE noted that the major differences between the current versions of the OSHA electrical installation standards and the proposed rule fall into the following categories:

• Changes in the hardware specifications that are consistent with NEC requirements,

• Changes in installation practices that are consistent with the current, accepted installation practices followed by licensed electricians and other qualified persons,

• Clarification of existing requirements that add minimal new obligations or otherwise permit flexibility in compliance, and

• Requirements that do significantly modify electrical system and equipment installation practices or impose new documentation requirements (Ex. 3–5).

He was concerned that the OSHA final rule would be functionally obsolete when it is published and, thus, have diminished utility in the future since most electricians are currently learning the NEC 2002 coding system. He argued that it would be beneficial for OSHA to use the same standard as those involved in electrical work.

OSHA has decided not to base the final rule as a whole on NFPA 70E–2004, which was published on April 9, 2004, shortly after OSHA's proposal was published. The 2004 version of the national consensus standard was not placed in the rulemaking record; therefore, the Agency does not believe that the public would have had adequate notice of the many changes in the latest NFPA standard, to the extent that the Agency would have incorporated these changes in the final rule. Basing Subpart S on the latest edition of NFPA 70E would thus necessitate reproposing the rule. Given the time involved in reproposing and finalizing an OSHA standard, it is likely that NFPA 70E will be revised yet again within that timeframe. In addition, because NFPA 70E and OSHA's electrical installation standard were developed specifically to minimize the need for revision with every new version of the NEC, a final rule based on the 2000 edition of NFPA 70E will not be obsolete. Furthermore, several provisions in the final rule are based on corresponding requirements in the 2002 NEC, on which NFPA 70E–2004 is based. (See the distribution table later in this section of the preamble.) In proposing and finalizing this revision of Subpart S, OSHA carefully chose which NEC changes would have the greatest impact on employee safety. The Agency does not believe that delaying the substantial increase in employee safety that would result from the standard published in the final rule is warranted.

On the other hand, where the rulemaking record supports specific requirements that are consistent with the 2004 edition of NFPA 70E, OSHA has adopted those requirements in the final rule. For example, final § 1910.304(b)(3)(ii)(A) is based, in part, on Section 410.4(B)(1) of the 2004 edition of NFPA 70E rather than Part I, Chapter 2, Section 2.4 of the 2000 edition of NFPA 70E. (See the detailed explanation, later in the preamble, discussing the rationale for this provision, which requires a written assured equipment grounding conductor program where ground-fault circuit-interrupters are not available.) In these specific cases, the rulemaking record supports OSHA's using the language from the relevant provision in NFPA 70E–2004 and from the 2002 NEC, on which the new NFPA 70E requirement is based. This avoids the notice problem discussed earlier. In addition, OSHA will consider using later versions of NFPA 70E to update the electrical installation requirements adopted in this final rule when the Agency develops future proposals to revise Subpart S to update the existing electrical safety-related work practice requirements and to adopt new provisions on safety-related maintenance and special equipment.

3. *OSHA should update the Electrical Standard for construction at the same time this rule is being promulgated.* The Agency received one comment asking OSHA to consider revising the Electrical Standard for construction at the same time as the revision to the Electrical Standard for general industry (Ex. 4–2). Reliable Safety Solutions, LLC, stated that installing equipment in general industry and installing equipment in the construction industry is much the same (Ex. 4–2). They argued that the hazards encountered are the same and the safe work practices when working with electricity are the same. Thus, they said that to update one standard and not the other would allow for one standard to be out of date and certain hazards to exist.

The Agency is aware that the general industry and the construction industry both address similar electrical hazards and have similar safe work practices. OSHA is also aware that its electrical standards for construction in 29 CFR 1926, Subpart K also need updating. Like Subpart S, Subpart K is based on the 1979 edition of NFPA 70E. In addition, the electrical safety-related work practices in Subpart K are even older than their general industry counterparts. However, OSHA must consult with the Advisory Committee on Construction Safety and Health before publishing a proposal. In addition, OSHA would have to include the construction industry in its regulatory analysis and repropose the standard to address construction as part of this rulemaking. Although OSHA will consider updating Subpart K to make it consistent with Subpart S in the future, it is not possible to do so as part of this final rule.

4. *OSHA should update the safety-related work practice requirements in Subpart S at the same time this rule is being promulgated.* One commenter recommended that OSHA revise its electrical safety-related work practice standard in Subpart S based on the corresponding requirements in NFPA 70E (Ex. 4–5). He argued that electricians encounter exposed energized parts of electric circuits, which demonstrates the need for the protective clothing and safe work practices contained in NFPA 70E.

OSHA agrees that the latest editions of NFPA 70E provide improved protection to employees through better electrical safety-related work practices. In particular, the heightened focus on the hazards posed by electric arcs may substantially reduce injuries and fatalities associated with those hazards. However, revising the safety-related work practice requirements in Subpart S is beyond the scope of this rulemaking. The Agency is planning to update these requirements as the next phase of the project to update OSHA's electrical standards. Although OSHA expects this phase of the project to yield significant benefits, the Agency also expects it to take longer to promulgate a final rule on safety-related work practices owing to the more complex regulatory analysis required and the greater controversy that is likely to be encountered.

B. Scope

Existing §§ 1910.302 through 1910.308 of Subpart S apply to electrical installations and utilization equipment used and installed in workplaces in general industry and in shipyard employment, longshoring, and marine terminals. These sections do not apply to the following types of installations:

(1) Installations in ships, watercraft, railway rolling stock, aircraft, or automotive vehicles other than mobile homes and recreational vehicles;

(2) Installations underground in mines; [5]

(3) Installations of railways for generation, transformation, transmission, or distribution of power used exclusively for operation of rolling stock or installations used exclusively for signaling and communication purposes;

(4) Installations of communication equipment under the exclusive control of communication utilities and located outdoors or in building spaces used exclusively for such installations; and

(5) Installations under the exclusive control of electric utilities for the purpose of communication or metering; or for the generation, control, transformation, transmission, and distribution of electric energy. These exempted installations must be located in buildings used exclusively by utilities for such purposes or located outdoors on property owned or leased

[5] This exception was incorporated into the current OSHA standard to be consistent with language used in the NEC and NFPA 70E. However, it should be noted that OSHA does not have jurisdiction over mines in general, regardless of whether the mining activity takes place above ground or underground. Under the Mine Safety and Health Act (MSH Act) (30 U.S.C. 801 *et seq.*), the Mine Safety and Health Administration (MSHA) regulates safety and health in mines. For further information, see the Interagency Agreement between MSHA and OSHA (*http://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=MOU&p_id=222*).

by the utility or on public highways, streets, roads, etc., or outdoors by established rights on private property.

These exempted installations present special design considerations that are not adequately addressed in Subpart S. For example, electric power transmission and distribution installations are typically installed where unqualified persons will not have access to them, and the only employees working on them are highly trained and skilled. Additionally, public safety considerations demand that these installations be capable of quick repair when weather or equipment failure disrupts electrical service. The National Electrical Safety Code (ANSI/IEEE C2), which is developed by experts in electric power generation, transmission, and distribution, contains design and installation requirements applicable to electric power generation, transmission, and distribution systems. Section 1910.269 contains OSHA's standard for the maintenance of electric power generation, transmission, and distribution installations. While it consists mostly of work-practice requirements, it does contain several installation requirements. For example, § 1910.269(u)(4) and (v)(4) cover guarding of rooms containing electric supply equipment in electric power generating stations and substations, respectively.

Installations in ships, watercraft, railway rolling stock, aircraft, or automotive vehicles (other than mobile homes and recreational vehicles) are designed to be transportable.[6] These transportability considerations make many of the design requirements in Subpart S irrelevant or infeasible. For example, attaching the grounded circuit conductor and the equipment grounding conductor to a permanent grounding electrode on a transportable wiring system is generally not feasible. Thus, some of the provisions in final § 1910.304(g), which contains requirements for grounding electrical systems, are inappropriate for the wiring of ships, watercraft, railway rolling stock, aircraft, or automotive vehicles. By contrast, however, wiring that is not a part of the wiring of the ship, watercraft, railway rolling stock, aircraft, or automotive vehicle would be covered by Subpart S, as appropriate. For example, a portable electric drill carried into the cargo area of a truck would be covered by Subpart S if it is plugged into the wiring of a service station.

In regard to ships, there has been some confusion about whether the ''exemption'' applies to all wiring or electrical installations brought on board a vessel during construction, repair, or ship scrapping even when the wiring is supplied by shore-based electric power—or whether it only applies to the ship's own wiring. OSHA is hereby clarifying the application of the exemptions.

The ''exempted'' types of installations in both the existing and final standards are identical to those ''exempted'' by the NEC and NFPA 70E, which form the basis of both standards. Installations covered under the existing standard continue to be covered under the final standard. For example, in longshoring operations and related employments, this final rule applies to electrical installations aboard vessels only if they are shore-based as stated in § 1918.1(b)(3). Electrical installations in marine terminals are also covered under Subpart S, as noted in § 1917.1(a)(2)(iv). (The marine terminals standard in Part 1917 applies to the loading, unloading, movement or other handling of cargo, ship's stores or gear within the terminal or into or out of any land carrier, holding or consolidation area, and any other activity within and associated with the overall operation and function of the terminal. This includes the use and routine maintenance of facilities and equipment and cargo transfer accomplished with the use of shore-based material handling devices. See § 1917.1(a).)

Section 1910.5 governs how the general industry standards apply to shipyard employment. According to § 1910.5(c), the general standards in Part 1910 apply to shipyard employment to the extent that no industry-specific standard applies to the ''same condition, practice, means, method, operation, or process.'' Part 1915 contains few requirements related to electrical safety. Paragraph (b) of § 1915.93 contains four such requirements, for grounding of vessels, the safety of the vessel's wiring, overcurrent protection, and guarding of infrared heat lamps. Section 1915.92 contains provisions on temporary electric lighting, and § 1915.132 contains requirements on portable electric tools. Section 1915.181 contains electrical safety-related work practices for deenergizing electric circuits and protecting employees against contact with live parts during electrical work. In addition, Part 1915 contains several other miscellaneous electrical safety-related work practices and electrical design requirements. These provisions continue to apply in lieu of any corresponding requirements in Subpart S of Part 1910. Conversely, where there is no specific electrical installation requirement for shipyard employment in Part 1915, Subpart S of Part 1910 applies.

As noted earlier, Subpart S does not cover installations in ships, but it does cover installations used on ships if the installation is shore-based (that is, not part of the vessel's original, internal electrical system). Thus, final § 1910.303(g)(2) (guarding live parts) applies to the shore-based wiring of the shipyard and to any wiring taken onto the ship when it is supplied by shore-based wiring. It does *not* apply to the ship's permanent wiring. The final rule does not change this coverage.

C. Grandfather Clause

The final rule, as does the current standard, exempts older electrical installations from meeting some of the provisions of the Design Safety Standards for Electrical Systems (that is, §§ 1910.302 through 1910.308). The extent to which OSHA's electrical installation standard applies depends on the date the installation was made. Older installations must meet fewer requirements than newer ones. The grandfathering of older installations, contained in paragraph (b) of final § 1910.302, is patterned after the current standard's grandfather provisions in existing § 1910.302(b). Most of the new provisions contained in the final rule only apply prospectively, to installations made after the effective date of the final rule.

The following paragraphs explain final § 1910.302(b) in the following order: Paragraph (b)(1), requirements applicable to all installations; paragraph (b)(4), requirements applicable only to installations made after the effective date of the revised standard; paragraph (b)(3), requirements applicable only to installations made after April 16, 1981; and paragraph (b)(2), requirements applicable only to installations made after March 15, 1972.

Requirements applicable to all installations. Paragraph (b)(1) of final § 1910.302 contains a list of provisions that would apply to all installations, regardless of when they were designed or installed. The few requirements in this short list are so essential to employee safety that even the oldest electrical installations must be modified, if necessary, to meet them. The list is unchanged from the current standard, except for the addition of: a prohibition on using grounding terminals and devices for purposes other than grounding (in final

[6] Although the wiring of recreational vehicles and mobile homes is transportable, it is also designed to be attached to specially designed, permanently installed power distribution outlets. This type of hybrid system must be designed for both permanent and transportable uses.

§ 1910.304(a)(3)); a documentation requirement for hazardous locations made under the zone classification system (in final § 1910.307(b)); and requirements covering the zone classification system (in final § 1910.307(g)).

New provisions applicable to all installations. Paragraph (a)(3) of § 1910.304 prohibits the use of a grounding terminal or grounding-type device on a receptacle, cord connector, or attachment plug for purposes other than grounding. OSHA's reasons for adding this requirement to the list of provisions applicable to all installations is discussed later in this section of the preamble.

Paragraph (b) of final § 1910.307 contains a new requirement that employers document areas designated as hazardous (classified) locations. This requirement would ensure that the employer has records of the extent and classification of each such area. The documentation will help employers to determine what type of equipment is needed in these locations and will inform employees of the need for special care in the maintenance of the electric equipment installed there. OSHA has carefully considered the need to document these areas and has tried to balance that need with the extensive burden that would be placed on employers who would have to survey and document their existing hazardous locations.

The current standard's division classification system has been in place for many years, and most employers and inspection authorities are familiar with the boundaries for Class I, II, and III, Division 1 and 2 locations. An employee servicing equipment in one of these locations can obtain this information relatively easily even if the employer has not documented the boundaries. Accordingly, OSHA believes that the benefit of documenting existing hazardous locations installed using the division classification system would be minimal. Therefore, for employers using the division system, OSHA is requiring documentation of boundaries only for new installations made after the effective date of the final standard. Employers would not need to document existing division-classified systems.

On the other hand, the zone classification system is relatively new. Most employers are not familiar with this system and have little experience determining how to draw the boundaries between the three zones. Relatively few NFPA or industry standards provide specifications for placing those boundaries. Furthermore, the existing OSHA electrical standard recognizes only installations made in accordance with the division classification system, not the zone classification system. Any existing installation made under the zone system is technically out of compliance with OSHA's existing standard. However, because the NEC represents standard industry practice, existing zone system installations will almost certainly have been installed in accordance with an edition of the NEC that recognizes the zone classification system (the 1999 and 2002 editions). These editions of the NEC explicitly require documentation of hazardous locations. Thus, an employer with an existing installation made under the zone classification system should already have the documentation required by final § 1910.307(b). For these reasons, OSHA is applying the documentation requirement to all hazardous location installations made under the zone classification system. This will provide employers, employees, and OSHA with information critical for determining which equipment is suitable in a given hazardous location.

The new requirements pertaining to zone classification in final § 1910.307(g) provide employers with an alternative installation method that the current standard does not permit.[7] Thus, applying these provisions to older installations would give employers greater flexibility without imposing any new costs. Furthermore, to the extent that employers are already using the zone classification system, those employers are likely already meeting final § 1910.307(g), which is based on provisions in the 1999 and 2002 editions of the NEC.

Requirements applicable only to installations made after the effective date of the final rule. Paragraph (b)(4) of final § 1910.302 makes the following provisions applicable only to installations made or overhauled[8] after the effective date of the final rule:

§ 1910.303(f)(4)	Disconnecting means and circuits—Capable of accepting a lock.
§ 1910.303(f)(5)	Disconnecting means and circuits—Marking for series combination ratings.
§ 1910.303(g)(1)(iv) and (g)(1)(vii)	600 Volts, nominal, or less—Space about electric equipment.
§ 1910.303(h)(5)(vi)	Over 600 volts, nominal—Working space and guarding.
§ 1910.304(b)(1)	Branch circuits—Identification of multiwire branch circuits.
§ 1910.304(b)(3)(i)	Branch circuits—Ground-fault circuit interrupter protection for personnel.
§ 1910.304(f)(2)(i)(A), (f)(2)(i)(B) (but not the introductory text to § 1910.304(f)(2)(i)), and (f)(2)(iv)(A).	Overcurrent protection—Feeders and branch circuits for over 600 volts, nominal.
§ 1910.305(c)(3)(ii)	Switches—Connection of switches.
§ 1910.305(c)(5)	Switches—Grounding.
§ 1910.306(a)(1)(ii)	Electric signs and outline lighting—Disconnecting means.
§ 1910.306(c)(4)	Elevators, dumbwaiters, escalators, moving walks, wheelchair lifts, and stairway chair lifts—Operation.
§ 1910.306(c)(5)	Elevators, dumbwaiters, escalators, moving walks, wheelchair lifts, and stairway chair lifts—Location.
§ 1910.306(c)(6)	Elevators, dumbwaiters, escalators, moving walks, wheelchair lifts, and stairway chair lifts—Identification and signs.
§ 1910.306(c)(7)	Elevators, dumbwaiters, escalators, moving walks, wheelchair lifts, and stairway chair lifts—Single-car and multicar installations.
§ 1910.306(j)(1)(iii)	Swimming pools, fountains, and similar installations—Receptacles.
§ 1910.306(k)	Carnivals, circuses, fairs, and similar events.
§ 1910.308(a)(5)(v) and (a)(5)(vi)(B)	Systems over 600 volts, nominal—Interrupting and isolating devices.
§ 1910.308(a)(7)(vi)	Systems over 600 volts, nominal—Tunnel installations.
§ 1910.308(b)(3)	Emergency power systems—Signs.

[7] See the discussion under the heading ''Zone Classification'' for an explanation of the zone classification system and its differences from the current standard's division classification system.

[8] See the discussion of the term ''overhaul'' later in this section of the preamble.

§ 1910.308(c)(3)	Class 1, Class 2, and Class 3 remote control, signaling, and power-limited circuits—Separation from conductors of other circuits.
§ 1910.308(f)	Solar photovoltaic systems.

These provisions are based on requirements that have been added to the NEC since the 1978 edition. OSHA has never required employers to comply with these requirements, and the Agency believes that an increase in employee protection will result from compliance with them in new installations. At the same time, employers would incur minimal costs to achieve this increase in new installations. In local jurisdictions requiring compliance with the NEC, there should be no additional costs involved, because the installations would already conform to the new OSHA requirements. The Agency believes that even in other jurisdictions, the vast majority of installations already comply with the latest edition of the NEC, because compliance with the latest Code is standard industry practice. OSHA, however, does not believe that it is reasonably necessary and appropriate to require existing installations to conform to these provisions, particularly given the cost and difficulty associated with retrofitting older installations.

There are many provisions in the final rule that are not contained in the existing standard but cannot be considered totally ''new'' provisions. Most of these ''new'' requirements were actually contained in the 1971 NEC. Table 1 lists these ''new'' provisions and denotes their counterparts in the 1971 NEC. From March 15, 1972, until April 16, 1981, Subpart S incorporated the 1971 NEC by reference in its entirety. Accordingly, OSHA required employers to comply with every requirement in the 1971 NEC for any new installation made between those dates and for any replacement, modification, repair, or rehabilitation made during that period. The current standard, which became effective on April 16, 1981, omitted many of the detailed provisions of the NEC because they were already addressed by the more general requirements that were contained in the OSHA standard. For example, OSHA did not carry forward 1971 NEC Section 110–11, which required equipment to be suitable for the environment if it is installed where the environment could cause deterioration. However, the requirement for equipment to be suitable for the location in which it was installed is implicit in the more general requirements in existing § 1910.303(a) that equipment be approved and in existing § 1910.303(b)(2) that equipment be installed in accordance with any instructions included in its listing or labeling. (Equipment that is not suitable for installation in deteriorating environments, such as wet or damp locations, will include instructions warning against such installation. These instructions are required by the nationally recognized testing laboratory listing or labeling the product.)

Even though OSHA no longer specifically incorporates the 1971 NEC into Subpart S, the Agency believes that employers' installations actually do comply with those requirements. The vast majority of employers are following the entire NEC applicable to their installations, as noted in the Economic Analysis section of this preamble.[9] For these reasons, OSHA is not exempting installations made after March 15, 1972, from meeting any provision listed in Table 1 and is not including any of these provisions in final § 1910.302(b)(4) (the list of provisions that apply only to new installations).

TABLE 1.—''NEW'' PROVISIONS THAT WERE CONTAINED IN 1971 NEC[10]

Provision in the final standard	Equivalent 1971 NEC section	Subject
§ 1910.303(b)(3)	110–20	Insulation integrity.
(b)(4)	110–9	Interrupting rating.
(b)(5)	10–10	Circuit impedance and other characteristics.
(b)(6)	110–11	Deteriorating agents.
(b)(7)	110–12	Mechanical execution of work.
(b)(8)	110–4(a) and (d) 110–12 110–13	Mounting and cooling of equipment.
(c)(1)	110–14	Electrical connections, general.
§ 1910.304(b)(2)	210–21(b)	Branch circuits, receptacles and cord connectors.
(b)(4)	210–21	Branch circuits, outlet devices.
(b)(5)	210–22	Branch circuits, cord connections.
(e)(1)(iii)	230–70(c)	Services, disconnecting means.
(f)(1)(ix)	110–9 240–11	Overcurrent protection, 600 volts, nominal, or less, circuit breaker ratings.
(f)(2), except for (f)(2)(i)(A), (f)(2)(i)(B), and (f)(2)(iv)(A).	240–5 240–11 240–15	Overcurrent protection, feeders and branch circuits over 600 volts, nominal.
§ 190.305(a)(4)(ii)	320–5	Open wiring on insulators, support.
(b)(1)(iii)	370–7 373–5	Conductors entering cabinets, boxes, and fittings, securing conductors.
(b)(2)(ii)	370–15(b)	Fixture canopy or pan installed in a combustible wall or ceiling.
(e)(1)	373–2 384–5	Airspace for enclosures installed in wet or damp locations.
(h)(3)	710–6	Portable cables, grounding conductors.

[9] All of the requirements in question appear in some form in every edition of the NEC since 1972.

[10] These provisions have no direct counterpart in existing Subpart S, but were in the 1971 National Electrical Code.

TABLE 1.—"NEW" PROVISIONS THAT WERE CONTAINED IN 1971 NEC [10]—Continued

Provision in the final standard	Equivalent 1971 NEC section	Subject
(j)(2)(i)	410–52(d)	Receptacles, cord connectors, and attachment plugs; no exposed energized parts.
(j)(2)(iv) through (j)(2)(vii)	410–54	Receptacles installed in wet or damp locations.
(j)(3)(ii)	422–20	Appliances, disconnecting means.
(j)(3)(iii)	422–30(a)	Appliances, nameplates.
(j)(3)(iv)	422–30(b)	Appliances, marking to be visible after installation.
(j)(6)(ii)(A)	110–9 110–10 460–8(c)(4)	Capacitor switches.
(j)(6)(ii)(B)	460–8(c)(1)	Capacitor disconnecting means.
§ 1910.306(c)(3)	620–51(a)	Elevators, dumbwaiters, escalators, moving walks, wheelchair lifts, and stairway chair lifts; type of disconnecting means.
(c)(10)	620–72	Elevators, dumbwaiters, escalators, moving walks, wheelchair lifts, and stairway chair lifts; motor controllers.
(d)(1)	630–13 630–23	Arc welders, disconnecting means.
(g)(1)(iii)	665–34	Induction and dielectric heating equipment, detachable panels used for access to live parts.
(g)(1)(vi)	665–8	Induction and dielectric heating equipment, ampere rating of disconnecting means.
(j)(4)(iii)	680–20(a)(4)	Swimming pools, fountains, and similar installations, underwater fixtures facing upwards.
§ 1910.308(a)(2)	710–4	Systems over 600 volts, nominal; open installations of braid-covered insulated conductors.
(a)(3)(i)	710–6	Systems over 600 volts, nominal; insulation shielding terminations.
(a)(4)	710–8	Systems over 600 volts, nominal; moisture or mechanical protection for metal-sheathed cables.
(a)(5)(i)	710–21(a)	Systems over 600 volts, nominal; interrupting and isolating devices; guarding and indicating.
(a)(5)(ii)	240–11(a) 710–21(b)	Systems over 600 volts, nominal; interrupting and isolating devices; fuses.
(a)(5)(iii) and (a)(5)(iv)	710–21(b)	Systems over 600 volts, nominal; interrupting and isolating devices; fused cutouts.
(a)(5)(vi), but not (a)(5)(vi)(B)	710–21(c)	Systems over 600 volts, nominal; interrupting and isolating devices; load interrupter switches.
(a)(5)(vii)	710–22	Systems over 600 volts, nominal; interrupting and isolating devices; means for isolating equipment.
(b)(2)	700–14	Emergency systems, emergency illumination.

In addition, OSHA is not including in the list of new provisions in final § 1910.302(b)(4) any provision that merely provides an alternative means of compliance for an existing requirement. For example, as noted earlier, final § 1910.307(g) provides alternative requirements for installations in hazardous (classified) locations based on the zone classification system rather than the division classification system that is required under the existing standard. Such requirements accept alternative installation techniques recognized as being equally protective by the NEC and NFPA 70E, and there is no need to limit them to new installations.

OSHA also believes that there is no need to grandfather requirements that apply only to temporarily installed equipment and wiring.[11] The few new requirements applying to temporarily installed equipment and wiring have been in the NEC since at least 1999 and, in most cases, since before that. Employers should already be in compliance with such requirements since any existing temporary installations almost certainly were put into place well after 1999.[12] For example, final § 1910.304(b)(3)(ii) contains requirements for providing ground-fault circuit interrupter protection for temporary wiring installations that are used during maintenance, remodeling, or repair of buildings, structures, or equipment or during similar activities. Temporary wiring installations used for any of these purposes were likely to have been installed well after 1999. An employer who is complying with the 1999 or later edition of the NEC will already be complying with this provision of the rule. Even employers who are not complying with recent versions of the NEC for temporary wiring installations will face, in this example, only the minimal cost of providing ground-fault circuit interrupters; no changes would need to be made to any existing permanent wiring, which might involve considerably more costs.

Requirements applicable only to installations made after April 16, 1981. Paragraph (b)(3) of final § 1910.302 lists requirements that apply only to installations made after April 16, 1981.

[11] For the purposes of this discussion, "temporarily installed equipment or wiring" is wiring and equipment installed on a short-term rather than a long-term or permanent basis. It includes temporary wiring covered by proposed § 1910.305(a)(2) and other equipment and wiring similarly installed on a short-term basis.

[12] The limit for temporary wiring used for Christmas decorative lighting, carnivals, and similar purposes is 90 days (§ 1910.305(a)(2)(i)(B)). For other purposes, such as remodeling and repair, the limit is the duration of the activity. However, OSHA believes that it is highly unlikely that any particular temporary activity covered by Subpart S has been on-going since 1999.

This paragraph carries forward essentially the same list as is currently in § 1910.302(b)(3). No provisions have been added to or removed from the list.

Requirements applicable only to installations made after March 15, 1972. Paragraph (b)(2) of existing § 1910.302 requires all installations made after March 15, 1972, and every major replacement, modification, repair, or rehabilitation made after that date to meet all the installation requirements in Subpart S except for those listed in existing § 1910.302(b)(3). A note following existing § 1910.302(b)(2) indicates that '' '[m]ajor replacements, modifications, repairs, or rehabilitations' include work similar to that involved when a new building or facility is built, a new wing is added, or an entire floor is renovated.''

Paragraph (b)(2) of final § 1910.302 will require all installations built or overhauled after March 15, 1972, to comply with all of the requirements of final §§ 1910.302 through 1910.308, except as provided in final § 1910.302(b)(3) and (b)(4). As discussed earlier, these latter two paragraphs limit the application of newer provisions of Subpart S to installations made during later periods.

In § 1910.302(b)(2) in the final rule, OSHA is introducing the term ''overhaul'' to include the types of activities that would trigger compliance with the otherwise grandfathered provisions of Subpart S for older installations. In § 1910.399 of the final rule, ''overhaul'' is defined as follows:

> *Overhaul* means to perform a major replacement, modification, repair, or rehabilitation similar to that involved when a new building or facility is built, a new wing is added, or an entire floor is renovated.

This new term incorporates all the elements of ''major replacement, modification, or rehabilitation'' in the text of existing § 1910.302(b)(2) and in the note following that provision. OSHA believes that using and defining the term ''overhaul'' in the final rule will simplify the standard without making any substantive change to the way in which Subpart S applies to older installations.

Comments on the grandfather clause. OSHA received several comments on the grandfather clause proposed in § 1910.302(b) (Exs. 3–7, 4–25). One commenter was concerned about the level of cross-referring an employer would need to do to determine what standards are applicable to a given installation (Ex. 3–7). He recommended that a simpler approach be adopted or that OSHA develop guidance materials to help employers determine which requirements apply to installations made during each of the periods addressed by the grandfather clause. Neither commenter proposed language that might accomplish this.

While OSHA acknowledges that some commenters believe that this clause is too complex, the Agency believes that the approach taken in the final standard is as simple as the Agency can make it. However, OSHA will provide compliance assistance tools that will help employers understand which requirements are applicable to their particular electrical installations. For example, the Agency is considering providing on the OSHA Website a color-coded version depicting requirements with different applicability dates with different colors or a version that lets the reader input the date of the installation and that hides inapplicable provisions. Such tools should enable employers to determine their compliance obligations quickly and easily. In addition, for questions about compliance with the standard, employers can contact OSHA through its toll-free telephone help line at 1–800–321–6742. Alternatively, employers can contact the OSHA Area Office or State Plan office nearest them.

Paragraph (b)(4) of final § 1910.302 lists § 1910.304(b)(3)(i) (proposed § 1910.304(b)(4)(i)), which requires ground-fault circuit interrupter protection for certain permanently installed receptacle outlets, as a provision that only applies to new installations. One commenter recommended that all of proposed § 1910.304(b)(4), which as noted previously contains requirements for ground-fault circuit interrupters on temporary receptacle outlets, apply only to new installations (Ex. 3–7). The commenter noted that this provision is new and should only be applied to new installations.

As noted earlier, OSHA believes that most employers are already complying with this provision. The National Electrical Code has required ground-fault circuit interrupters in a manner similar to that in the final rule since the 1996 edition of the NEC. In addition, the final rule sets an effective date 180 days after publication of the final rule in the **Federal Register**. OSHA believes that very few temporary installations that were in place before publication of the final rule will still be in place 6 months later. There may be some projects using temporary wiring that last more than 6 months, particularly in shipyards. However, even there, OSHA believes that temporary receptacle outlets will be moved around, installed, uninstalled, and reinstalled many times over the life of the project. Even if the Agency were to apply final § 1910.304(b)(3)(ii) only to installations made after the effective date, it would apply as soon as a receptacle outlet was installed (or reinstalled). OSHA does not believe that there is a compelling reason to exempt the very few remaining temporary receptacle outlets that may still be in place after the effective date. Therefore, OSHA has not adopted the commenter's recommendation.

Mr. Pat Kimmet of CHS Inc. and Mr. Rick Leicht of NCRA were concerned that provisions listed in proposed § 1910.302(b)(1), which were to apply to all installations regardless of age, would require employers to examine existing installations for compliance and possibly replace noncompliant equipment even when no significant hazard exists (Ex. 4–25). They specifically objected to the inclusion of wire bending space (proposed § 1910.303(b)(1)(iii)) on the list. They argued that this provision is a relatively recent addition to the NEC and that the NEC has revised the wire bending space requirements periodically. They believed that the proposal would have required employers to meet the wire bending space requirements in the 2000 edition of the NFPA 70E and the 2002 edition of the NEC.

OSHA believes that an installation that does not comply with the provisions listed in final § 1910.302(b)(1) poses a significant hazard to employees. Furthermore, as noted earlier, almost all of the provisions listed in that paragraph applied to all installations regardless of age since March 15, 1972. Thus, employers should already be in compliance with nearly all of the listed provisions.

The new provisions related to the zone classification system (including the documentation requirement) provide for an alternative compliance method to that required by the existing standard. The other new provision, the prohibition on using grounding terminals and devices for purposes other than grounding, as noted earlier, has been a long-standing NEC requirement. Thus, OSHA does not believe that very many existing installations are in violation of this new provision. Consequently, Mr. Kimmet's and Mr. Leicht's general concerns about widespread noncompliance are unfounded.

With respect to their specific concern with the inclusion of proposed § 1910.303(b)(1)(iii) in the list of provisions applicable to all installations, OSHA notes that wire bending space, as mentioned in this provision, is simply one of several

factors to be considered in judging electrical equipment for safety. Paragraph (b)(1) of final § 1910.303 reads, in part, as follows:

(b) *Examination, installation, and use of equipment.* (1) *Examination.* Electric equipment shall be free from recognized hazards that are likely to cause death or serious physical harm to employees. Safety of equipment shall be determined using the following considerations:

* * * * *

(iii) Wire-bending and connection space;

* * * * *

(viii) Other factors that contribute to the practical safeguarding of persons using or likely to come in contact with the equipment.

Paragraph (b)(1)(iii) of final § 1910.303 does not require compliance with the minimum wire bending space requirements in the NEC. Rather, wire bending space will be one of the relevant factors in judging the electrical safety of equipment in accordance with the introductory text of final § 1910.303(b)(1). OSHA does not consider this a new requirement. The current standard contains the catchall ''other factors'' language in existing § 1910.303(b)(1)(vii). The Agency construes wire bending space to be one of those ''other factors'' judged under the existing standard. Thus, OSHA is simply making explicit in the final rule a factor employers were required to consider under § 1910.303(b)(1)(vii) of the existing standard. If conductors are installed so tightly into enclosures that they overheat or that the insulation is damaged, a serious safety hazard would exist. Such an installation would violate the existing standard as well as the new one. For these reasons, OSHA has not adopted Mr. Kimmet's and Mr. Leicht's recommendation to remove § 1910.303(b)(1)(iii) from the list of provisions in final § 1910.302(b)(1) that apply to all installations.

Several commenters suggested that proposed § 1910.304(a)(3) be added to the list of requirements in § 1910.302(b)(1) applicable to all installations (Exs. 4–13, 4–17, 4–18, 4–21). Proposed § 1910.304(a)(3) read as follows:

A grounding terminal or grounding-type device on a receptacle, cord connector, or attachment plug may not be used for purposes other than grounding.

Mr. Bernie Ruffenach typified these commenters, reasoning as follows:

The use of the grounding terminal(s) of any device has never been permitted in any electrical standards, codes or other recognized practices at any time. Typically, the use of the grounding terminal for other than grounding purposes is due to improper wiring and occurs when an ungrounded (hot) conductor is applied. The result is an imminent danger electrocution hazard. [Ex. 4–17]

OSHA agrees that using a grounding terminal or device for purposes other than grounding can present a hazard threatening imminent death or serious injury. For example, using a grounding terminal as the attachment point for a circuit conductor can energize the frame of equipment used by employees. If an employee was to touch such miswired equipment and a grounded surface at the same time, he or she would receive an electric shock and possibly die of electrocution. As the commenters noted, compliance with this provision has been a long-standing common industry practice. Therefore, OSHA has adopted the suggestion of these commenters and has added § 1910.304(a)(3) to the list of provisions in final § 1910.302(b)(1) that are applicable to all installations.

D. Applicability of Requirements for Disconnecting Means

Several provisions in the final standard require electrical disconnecting means to be capable of being locked in the open position under certain conditions. For example, final § 1910.306(a)(2)(i) requires the disconnecting means for sign and outline lighting systems to be capable of being locked in the open position if they are out of the line of sight from any section that may be energized. These provisions ensure that employees servicing or maintaining the electric circuits supplied by the disconnecting means are protected against electric shock.

Sometimes, these disconnecting means also serve as energy isolating devices as defined in paragraph (b) of § 1910.147, OSHA's existing standard for the control of hazardous energy sources (lockout-tagout). Energy isolating devices physically prevent the transmission or release of energy. In the case of electric equipment, disconnecting means that meet the definition of energy isolating devices prevent the transmission of electric energy so that the equipment cannot start up and injure employees.

Paragraph (c)(2)(iii) of the lockout-tagout standard reads as follows:

After January 2, 1990, 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 machine or equipment shall be designed to accept a lockout device.

Paragraph (c) of final § 1910.302 clarifies that the provision in the lockout-tagout standard is in addition to any requirements in Subpart S for disconnecting means to be capable of being locked open. The requirements in Subpart S are intended for the protection of servicing and maintenance employees from electric shock, which is not covered by § 1910.147. The lockout-tagout standard on the other hand addresses nonelectric-shock hazards related to servicing and maintaining equipment. Thus, the requirements of both standards are necessary to protect employees from all servicing- and maintenance-related hazards.

OSHA received no comments on this provision in the proposal, and it is being carried into the final rule without change.

E. Summary of Changes in §§ 1910.303 Through 1910.308

The Distribution Table for Subpart S lists all the provisions and sections from §§ 1910.303 through 1910.308. This table summarizes changes being made to the standard that involve grammatical edits, additions, removals, and paragraph numbers. There are places in the standard where no substantial change is made. Most of the changes are editorial in nature. Substantive changes made to the existing standard are discussed in further detail following the Distribution Table.

DISTRIBUTION TABLE

OLD—section	NEW—section	Description of changes and rationale
See the note at the end of the table.		
§ 1910.303 General	§ 1910.303 General.	
1910.303(a)	1910.303(a)	No substantive change. A reference to the § 1910.399 definition of ''approved'' is added for clarification.
1910.303(b)(1), introductory text	1910.303(b)(1), introductory text	No substantive change.
1910.303(b)(1)(i)	1910.303(b)(1)(i)	No substantive change.

DISTRIBUTION TABLE—Continued

OLD—section	NEW—section	Description of changes and rationale
1910.303(b)(1)(ii)	1910.303(b)(1)(ii)	No substantive change.
	1910.303(b)(1)(iii)	**Adds wire-bending and connection space to the explicit list of things to consider when judging equipment.
1910.303(b)(1)(iii)	1910.303(b)(1)(iv)	No substantive change.
1910.303(b)(1)(iv)	1910.303(b)(1)(v)	No substantive change.
1910.303(b)(1)(v)	1910.303(b)(1)(vi)	No substantive change.
1910.303(b)(1)(vi)	1910.303(b)(1)(vii)	No substantive change.
1910.303(b)(1)(vii)	1910.303(b)(1)(viii)	No substantive change.
1910.303(b)(2)	1910.303(b)(2)	No substantive change.
	1910.303(b)(3)	**Adds a requirement for completed wiring to be free from short circuits and grounds other than those required in the standard.
	1910.303(b)(4)	**Adds requirements for equipment intended to interrupt current to have adequate interrupting ratings.
	1910.303(b)(5)	**Adds requirements for the coordination of overcurrent protection for circuits and equipment.
	1910.303(b)(6)	**Adds a requirement for conductors and equipment to be identified for the purpose when installed in an environment containing deteriorating agents.
	1910.303(b)(7)	**Adds requirements for installing electric equipment in a neat and workmanlike manner.
	1910.303(b)(8)	**Adds requirements for equipment to be mounted securely and to allow for proper cooling.
	1910.303(c)(1)	**Adds requirements to ensure that electrical connections are secure and electrically safe.
	1910.303(c)(2)	**Adds requirements for connections at terminals and for the identification of terminals intended for connection to more than one conductor or to aluminum.
1910.303(c)	1910.303(c)(3)(i)	No substantive change.
	1910.303(c)(3)(ii)	**Adds a requirement that wire connectors or splicing means installed on directly buried conductors be listed for such use.
1910.303(d)	1910.303(d)	No substantive change.
1910.303(e)	1910.303(e)	No substantive change. (Individual requirements are placed in separate paragraphs).
1910.303(f)	1910.303(f)(1), (f)(2), and (f)(3)	No substantive change. (Individual requirements are placed in separate paragraphs).
	1910.303(f)(4)	Adds a requirement for disconnecting means required by Subpart S to be capable of accepting a lock. This provision is added to make the Subpart S requirements on disconnecting means consistent with § 1910.147(c)(2)(iii), which requires energy isolating devices (a generic term, which includes electrical disconnecting means) to be designed to accept a lockout device.
	1910.303(f)(5)	**Adds marking requirements for series combination ratings of circuit breakers or fuses.
1910.303(g)(1), introductory text	1910.303(g)(1), introductory text	No substantive change.
1910.303(g)(1)(i)	1910.303(g)(1)(i) Table S–1, Note 3.	**The final rule revises the language to clarify how wide and high the clear space must be. (See detailed explanation later in the preamble).
1910.303(g)(1)(ii)	1910.303(g)(1)(ii)	No substantive change.
1910.303(g)(1)(iii)	1910.303(g)(1)(iii)	No substantive change.
	1910.303(g)(1)(iv)	**Adds a requirement for a second entrance on equipment rated 1200 amperes under certain conditions.
1910.303(g)(1)(iv)	1910.303(g)(1)(i)(B)	**Reduces the minimum width of the clear space to 762 mm.
1910.303(g)(1)(v)	1910.303(g)(1)(v)	**Adds a prohibition against controlling illumination for working spaces by automatic means only.
1910.303(g)(1)(vi)	1910.303(g)(1)(vi)	**Increased the minimum height of the working space from 1.91m to 1.98m for new installations.
	1910.303(g)(1)(vii)	** Adds requirements for switchboards, panelboards, and distribution boards installed for the control of light and power circuits, and motor control centers to be installed in dedicated space and to be protected against damage.
1910.303(g)(2)	1910.303(g)(2)	No substantive change.
1910.303(h)(1)	1910.303(h)(1)	No substantive change.
1910.303(h)(2), introductory text	1910.303(h)(2)(i) and (h)(2)(ii)	**The minimum height of fences restricting access to electrical installations over 600 V is reduced from 2.44 m to 2.13 m.
1910.303(h)(2)(i) and (h)(2)(ii)	1910.303(h)(2)(iii), (h)(2)(iv), (h)(2)(v), and (h)(5)(iii).	**1. The final rule organizes these requirements based on whether the installations are indoors or outdoors. (The existing standard organizes them based on whether or not the installations are accessible to unqualified employees). 2. Adds requirements intended to prevent tampering by the general public. 3. Removes requirement to lock underground box covers weighing more than 45.4 kg.

DISTRIBUTION TABLE—Continued

OLD—section	NEW—section	Description of changes and rationale
1910.303(h)(3), introductory text	1910.303(h)(3)	No substantive change.
1910.303(h)(3)(i)	1910.303(h)(5)(i) Table S–2, Note 3.	**The distances in Table S–2 for the depth of working space in front of electric equipment are increased for new installations to match the distances in NFPA 70E–2000.
1910.303(h)(3)(ii)	1910.303(h)(5)(iv)	No substantive change.
1910.303(h)(3)(iii)	1910.303(h)(5)(v)	**The distances in Table S–3 for the elevations of unguarded live parts are increased for new installations to match the distances in NFPA 70E–2000.
1910.303(h)(4)(i)	1910.303(h)(4)(i)	**The existing standard requires a second entrance to give access to the working space about switchboards and control panels over 600 V if the equipment exceeds 1.22 m in width if it is practical to install a second entrance. The final rule requires an entrance on each end of switchboards and panelboards exceeding 1.83 m unless the working space permits a continuous and unobstructed way of travel or the working space is doubled. In addition, the final rule requires the lone entrance permitted under either of these exceptions to be at least the distance specified in Table S–2 from exposed live parts.
1910.303(h)(4)(ii)	1910.303(h)(4)(ii)	No substantive change.
	1910.303(h)(5)(ii)	**Adds requirements for equipment operating at 600 V or less installed in rooms or enclosures containing exposed live parts or exposed wiring operating at more than 600 V.
	1910.303(h)(5)(vi)	**Adds requirements limiting the installation of pipes or ducts that are foreign to electrical installation operating at more than 600 V.
§ 1910.304 Wiring design and protection.	§ 1910.304 Wiring design and protection.	
1910.304(a)(1)	1910.304(a)(1)	No substantive change. (Individual requirements are placed in separate paragraphs).
1910.304(a)(2)	1910.304(a)(2)	No substantive change.
1910.304(a)(3)	1910.304(a)(3)	No substantive change.
	1910.304(b)(1)	**Adds requirements for the identification of multiwire branch circuits.
	1910.304(b)(2)(i)	**Adds requirements that receptacles installed on 15- and 20-ampere circuits be of the grounding type and that grounding-type receptacles be installed in circuits within their rating.
	1910.304(b)(2)(ii)	**Adds a requirement for grounding contacts on receptacles to be effectively grounded.
	1910.304(b)(2)(iii)	**Adds requirements on the methods used to ground receptacles and cord connectors.
	1910.304(b)(2)(iv)	**Adds requirements on the replacement of receptacles.
	1910.304(b)(2)(v)	**Adds a requirement that receptacles installed on branch circuits having different voltages, frequencies, or types of current be noninterchangeable.
	1910.304(b)(3)	**Adds requirements for ground fault circuit interrupter protection. (See the discussion of these requirements later in this section of the preamble).
1910.304(b)(2)	1910.304(b)(4), introductory text	No significant change.
	1910.304(b)(4)(i)	**Adds requirements for ratings of lampholders.
	1910.304(b)(4)(ii)	**Adds requirements for ratings of receptacles.
	1910.304(b)(5)	**Adds requirements for receptacles to be installed wherever cords with attachment plugs are used.
1910.304(c), introductory text	1910.304(c), introductory text	No significant change. (The requirements in existing paragraph (c)(5) are placed in a separate paragraph (d)).
1910.304(c)(1)	1910.304(c)(1)	**Adds a requirement for the separation of conductors on poles.
1910.304(c)(2)	1910.304(c)(2)	Increases the minimum clearances for new installations of open conductors and service drops to match those in NFPA 70E–2000.
1910.304(c)(3)	1910.304(c)(3)(i)	No substantive change. (The final rule clarifies that paragraph (c)(2) applies to platforms, projections, or surfaces from which runs of open conductors can be reached).
	1910.304(c)(3)(ii)	**Adds restrictions for installing overhead service conductors near building openings through which materials may be moved.
1910.304(c)(4)	1910.304(c)(4)	**Adds an exception to the minimum clearance requirement for conductors attached to the side of a building. (The final rule also clarifies that paragraph (c)(2) applies to roof surfaces that are subject to pedestrian or vehicular traffic).
1910.304(c)(5)	1910.304(d)	No substantive change.
1910.304(d)(1)(i)	1910.304(e)(1)(i)	No substantive change.
1910.304(d)(1)(ii)	1910.304(e)(1)(ii)	No substantive change.
	1910.304(e)(1)(iii)	**Adds a requirement for service disconnecting means to be suitable for the prevailing conditions.
1910.304(d)(2)	1910.304(e)(2)	No substantive change.
1910.304(e)(1), introductory text	1910.304(f)(1), introductory text	No substantive change.
1910.304(e)(1)(i)	1910.304(f)(1)(i)	No substantive change.

DISTRIBUTION TABLE—Continued

OLD—section	NEW—section	Description of changes and rationale
1910.304(e)(1)(ii)	1910.304(f)(1)(ii)	No substantive change.
1910.304(e)(1)(iii)	1910.304(f)(1)(iii)	**The types of circuits that are allowed to have a single switch disconnect for multiple fuses are now specified in the standard.
1910.304(e)(1)(iv)	1910.304(f)(1)(iv)	No substantive change.
1910.304(e)(1)(v)	1910.304(f)(1)(v)	**Adds a requirement to clarify that handles of circuit breakers and similar moving parts also need to be guarded so that they do not injure employees.
1910.304(e)(1)(vi)(A)	1910.304(f)(1)(vi)	No substantive change.
1910.304(e)(1)(vi)(B)	1910.304(f)(1)(vii)	No substantive change.
1910.304(e)(1)(vi)(C)	1910.304(f)(1)(viii)	**Adds circuit breakers used on 277-volt fluorescent lighting circuits to the types of breakers required to be marked ''SWD.''
	1910.304(f)(1)(ix)	**Adds a requirement to clarify ratings of circuit breakers.
1910.304(e)(2)	1910.304(f)(2)	**Adds specific requirements on how to protect feeders and branch circuits energized at more than 600 volts.
1910.304(f), introductory text	1910.304(g), introductory text	No substantive change.
1910.304(f)(1), introductory text	1910.304(g)(1), introductory text	No substantive change.
1910.304(f)(1)(i)	1910.304(g)(1)(i)	No substantive change.
1910.304(f)(1)(ii)	1910.304(g)(1)(ii)	No substantive change.
1910.304(f)(1)(iii)	1910.304(g)(1)(iii)	No substantive change.
1910.304(f)(1)(iv)	1910.304(g)(1)(iv)	No substantive change. (The specific voltage ratings in existing paragraphs (g)(1)(iv)(B) and (g)(1)(iv)(C) are being removed. However, this is not a substantive change as those are the voltages used in the described systems).
1910.304(f)(1)(v)	1910.304(g)(1)(v)	**Adds an exception to the requirement to ground systems for high-impedance grounded systems of 480 V to 1000 V under certain conditions.
1910.304(f)(2)	1910.304(g)(2)	**No substantive change. (The standard adds descriptions of which conductor is to be grounded for the different systems).
	1910.304(g)(3)	**Changes requirements for grounding portable and vehicle mounted generators so that the requirements are equivalent to those in OSHA's Construction Standards (§ 1926.404(f)(3)). The sentence in the construction standard reading: ''No other [nonneutral] conductor need be bonded to the generator frame'' has been dropped from the general industry version. This sentence is not regulatory in nature, and its omission has no effect on the requirement.
1910.304(f)(3)	1910.304(g)(4)	**No longer allows employers to use a cold water pipe as a source of ground for installations made or modified after the effective date.
1910.304(f)(4)	1910.304(g)(5)	**Adds a requirement that the path to ground be effective.
1910.304(f)(5)(i)	1910.304(g)(6)(i)	No substantive change.
1910.304(f)(5)(ii)	1910.304(g)(6)(ii)	No substantive change.
1910.304(f)(5)(iii)	1910.304(g)(6)(iii)	No substantive change.
1910.304(f)(5)(iv)	1910.304(g)(6)(iv) and (g)(6)(v)	**The exceptions for grounding fixed equipment operating at more than 150 V are extended to all fixed electric equipment regardless of voltage. Also, the final rule includes a new exception for double-insulated equipment.
1910.304(f)(5)(v)	1910.304(g)(6)(vi) and (g)(6)(vii)	**Adds the following equipment to the list of cord- and plug-connected equipment required to be grounded: stationary and fixed motor-operated tools and light industrial motor-operated tools.
1910.304(f)(5)(vi)	1910.304(g)(7)	**Adds frames and tracks of electrically operated hoists to the list of nonelectrical equipment required to be grounded.
1910.304(f)(6)	1910.304(g)(8)	No substantive change.
1910.304(f)(7)(i)	1910.304(g)(9), introductory text	No substantive change.
1910.304(f)(7)(ii)	1910.304(g)(9)(i)	No substantive change.
1910.304(f)(7)(iii)	1910.304(g)(9)(ii)	No substantive change.
§ 1910.305 Wiring methods, components, and equipment for general use.	§ 1910.305 Wiring methods, components, and equipment for general use.	
1910.305(a), introductory text	1910.305(a), introductory text	No substantive change.
1910.305(a)(1)(i)	1910.305(a)(1)(i)	**Adds a requirement that equipment be bonded so as to provide adequate fault-current-carrying capability. Also, clarifies that nonconductive coatings need to be removed unless the fittings make this unnecessary.
	1910.305(a)(1)(ii)	**Adds an exception to the bonding requirement for the reduction of electrical noise.
1910.305(a)(1)(ii)	1910.305(a)(1)(iii)	No substantive change.

DISTRIBUTION TABLE—Continued

OLD—section	NEW—section	Description of changes and rationale
1910.305(a)(2), introductory text	1910.305(a)(2), introductory text ...	No substantive change. Removes the provision allowing temporary wiring to be of a class less than permanent wiring per the 2002 NEC. The change has no substantive effect because: (1) The term ''a class less than'' is not defined, and (2) temporary wiring is required to meet the same requirements regardless of the deleted language. (Both the final rule and the existing standard contain the following requirement: ''Except as specifically modified in this paragraph, all other requirements of this subpart for permanent wiring shall apply to temporary wiring installations.'').
1910.305(a)(2)(i), introductory text	1910.305(a)(2)(i), introductory text	No substantive change.
1910.305(a)(2)(i)(A)	1910.305(a)(2)(i)(A)	Removes demolition from the list of activities for which temporary wiring is permitted. Demolition is a form of construction work, which is not covered by the Subpart S installation requirements.
1910.305(a)(2)(i)(B)	1910.305(a)(2)(i)(C)	**Adds emergencies to the list of activities for which temporary wiring is permitted.
1910.305(a)(2)(i)(C)	1910.305(a)(2)(i)(B)	No substantive change.
	1910.305(a)(2)(ii)	**Clarifies that temporary wiring must be removed when the project or purpose for which it was used has been completed.
1910.305(a)(2)(ii)	1910.305(a)(2)(iii)	**Adds ''construction-like activities'' to the list of permitted uses for temporary electrical installations over 600 volts.
1910.305(a)(2)(iii)(A)	1910.305(a)(2)(iv)	**Feeders may now only be run as single insulated conductors when accessible to qualified employees only and used for experiments, development work, or emergencies. (Individual requirements are placed in separate paragraphs).
1910.305(a)(2)(iii)(B)	1910.305(a)(2)(v)	No substantive change. (Individual requirements are placed in separate paragraphs).
1910.305(a)(2)(iii)(C)	1910.305(a)(2)(vi)	No substantive change.
1910.305(a)(2)(iii)(D)	1910.305(a)(2)(vii)	No substantive change.
1910.305(a)(2)(iii)(E)	1910.305(a)(2)(viii)	**Adds a requirement that disconnecting means for a multiwire circuit simultaneously disconnect all ungrounded conductors of the circuit.
1910.305(a)(2)(iii)(F)	1910.305(a)(2)(ix)	**This provision no longer allows installing fixtures or lampholders more than 2.1 meters above the working surface as a means of guarding. Also, the final rule adds a requirement for grounding metal-case sockets.
1910.305(a)(2)(iii)(G)	1910.305(a)(2)(x)	No substantive change.
	1910.305(a)(2)(xi)	**Adds requirements for cable assemblies and flexible cords and cables to be adequately supported.
1910.305(a)(3)(i)(a)	1910.305(a)(3)(i)	No substantive change. (Some raceway and cable types that were included in generic terms have been explicitly added to the list of wiring methods acceptable in cable trays).
1910.305(a)(3)(i)(b)	1910.305(a)(3)(ii)	**Adds several types of cables and single insulated conductors to the list of types permitted in industrial establishments.
	1910.305(a)(3)(iii)	**Adds a requirement limiting the use of metallic cable trays as an equipment grounding conductor.
1910.305(a)(3)(i)(c)	1910.305(a)(3)(iv)	No substantive change.
1910.305(a)(3)(ii)	1910.305(a)(3)(v)	No substantive change.
1910.305(a)(4)(i)	1910.305(a)(4)(i)	No substantive change.
1910.305(a)(4)(ii)	1910.305(a)(4)(ii)	**Adds specific support requirements and limits the application of these requirements to conductors smaller than No. 8.
1910.305(a)(4)(iii)	1910.305(a)(4)(iii)	No substantive change.
1910.305(a)(4)(iv)	1910.305(a)(4)(iv)	No substantive change.
1910.305(a)(4)(v)	1910.305(a)(4)(v)	No substantive change.
1910.305(b)(1)	1910.305(b)(1)(i) and (b)(1)(ii)	No substantive change. (Individual requirements are placed in separate paragraphs).
	1910.305(b)(1)(iii)	**Adds requirements for supporting cables entering cabinets, cutout boxes, and meter sockets.
1910.305(b)(2)	1910.305(b)(2)(i)	No substantive change.
	1910.305(b)(2)(ii)	**Adds a requirement for any exposed edge of a combustible ceiling finish at a fixture canopy or pan to be covered with noncombustible material.
1910.305(b)(3)	1910.305(b)(3)	No substantive change. (Individual requirements are placed in separate paragraphs).
1910.305(c)(1)	1910.305(c)(1), (c)(2), and (c)(3)(i)	No substantive change. (Individual requirements are placed in separate paragraphs).
	1910.305(c)(3)(ii)	**Adds a requirement for load terminals on switches to be deenergized when the switches are open except under limited circumstances.
	1910.305(c)(4)	**Adds a specific requirement for flush-mounted switches to have faceplates that completely cover the opening and that seat against the finished surface.
1910.305(c)(2)	1910.305(c)(5)	**Adds a requirement to ground faceplates for snap switches.

DISTRIBUTION TABLE—Continued

OLD—section	NEW—section	Description of changes and rationale
1910.305(d)	1910.305(d)	No substantive change. (Individual requirements are placed in separate paragraphs).
1910.305(e)(1)	1910.305(e)(1)	**Adds a requirement for metallic cabinets, cutout boxes, fittings, boxes, and panelboard enclosures installed in damp or wet locations to have an air space between the enclosure and the mounting surface.
1910.305(e)(2)	1910.305)(e)(2)	No substantive change.
1910.305(f)	1910.305(f)	No substantive change. (Individual requirements are placed in separate paragraphs).
1910.305(g)(1)(i)	1910.305(g)(1)(i) and (g)(1)(ii)	**Adds the following to the types of connections permitted for flexible cords and cables: Portable and mobile signs and connection of moving parts. The final rule also clarifies that flexible cords and cables may be used for temporary wiring as permitted in final § 1910.305(a)(2).
1910.305(g)(1)(ii)	1910.305(g)(1)(iii)	No substantive change.
1910.305(g)(1)(iii)	1910.305(g)(1)(iv)	No substantive change. (Clarifies that flexible cords and cables may not be installed inside raceways).
1910.305(g)(1)(iv)	1910.305(g)(1)(v)	**Permits additional cord types to be used in show windows and show cases.
1910.305(g)(2)(i)	1910.305(g)(2)(i)	**Adds new types of cords to the list of those that must be marked with their type designation.
1910.305(g)(2)(ii)	1910.305(g)(2)(ii)	**Changes the minimum size of hard service and junior hard service cords that may be spliced from No. 12 to 14.
1910.305(g)(2)(iii)	1910.305(g)(2)(iii)	No substantive change.
1910.305(h)	1910.305(h), introductory text, (h)(1), (h)(2), (h)(3), (h)(6), (h)(7), and (h)(8).	**Permits the minimum size of the insulated ground-check conductor of Type G–GC cables to be No. 10 rather than No. 8. (Individual requirements are placed in separate paragraphs).
	1910.305(h)(4)	**Adds a requirement for shields to be grounded.
	1910.305(h)(5)	**Adds minimum bending radii requirements for portable cables.
1910.305(i)(1)	1910.305(i)(1)	No substantive change.
1910.305(i)(2)	1910.305(i)(2)	No substantive change.
1910.305(i)(3)	1910.305(i)(3)	**Also permits fixture wire to be used in fire alarm circuits.
1910.305(j)(1)(i)	1910.305(j)(1)(i)	No substantive change.
1910.305(j)(1)(ii)	1910.305(j)(1)(ii)	No substantive change. (Clarifies that metal-shell paper-lined lampholders may not be used for handlamps).
1910.305(j)(1)(iii)	1910.305(j)(1)(iii)	**Adds a requirement that the grounded circuit conductor, where present, be connected to the screw shell.
1910.305(j)(1)(iv)	1910.305(j)(1)(iv)	No substantive change.
	1910.305(j)(2)(i)	**Adds requirements to ensure that attachment plugs and connectors have no exposed live parts.
1910.305(j)(2)(i)	1910.305(j)(2)(ii)	No substantive change.
	1910.305(j)(2)(iii)	**Clarifies that nongrounding-type receptacles may not be used with grounding-type attachment plugs.
1910.305(j)(2)(ii)	1910.305(j)(2)(iv)	No substantive change.
	1910.305(j)(2)(v), (j)(2)(vi), and (j)(2)(vii).	**Adds requirements for receptacles outdoors to be installed in weatherproof enclosures appropriate for the use of the receptacle and for the location.
1910.305(j)(3)(i)	1910.305(j)(3)(i)	No substantive change.
1910.305(j)(3)(ii)	1910.305(j)(3)(ii)	**Adds a requirement to group and identify disconnecting means for appliances supplied by more than one source.
1910.305(j)(3)(iii)	1910.305(j)(3)(iii)	**Adds requirements for marking frequency and required external overload protection for appliances.
	1910.305(j)(3)(iv)	**Clarifies that markings must be visible or easily accessible after installation.
1910.305(j)(4), introductory text	1910.305(j)(4), introductory text	No substantive change.
1910.305(j)(4)(i)	1910.305(j)(4)(i)	No substantive change.
1910.305(j)(4)(ii)(A)	1910.305(j)(4)(ii)	No substantive change.
1910.305(j)(4)(ii)(B)	1910.305(j)(4)(iii)	No substantive change.
1910.305(j)(4)(ii)(C)		Removed. All disconnecting means must be capable of being locked in the open position by §§ 1910.302(c) and 1910.303(f)(4).
1910.305(j)(4)(ii)(D)	1910.305(j)(4)(iv)	No substantive change.
1910.305(j)(4)(ii)(E)	1910.305(j)(4)(v)	No substantive change.
1910.305(j)(4)(ii)(F)	1910.305(j)(4)(vi)	No substantive change.
1910.305(j)(4)(iii)	1910.305(j)(4)(vii)	No substantive change.
1910.305(j)(4)(iv)(A)		Removed. Covered by § 1910.303(g)(2), (h)(2), and (h)(4)(iii).
1910.305(j)(4)(iv)(B)	1910.305(j)(4)(viii)	No substantive change.
1910.305(j)(5)(i)	1910.305(j)(5)(i)	No substantive change.
1910.305(j)(5)(ii)	1910.305(j)(5)(ii)	No substantive change.
1910.305(j)(5)(iii)	1910.305(j)(5)(iii)	No substantive change.

DISTRIBUTION TABLE—Continued

OLD—section	NEW—section	Description of changes and rationale
1910.305(j)(5)(iv)	1910.305(j)(5)(iv)	No substantive change. (Oil-insulated transformers installed indoors are presumed to present a hazard to employees since a transformer failure will lead to a fire within the building unless the transformer is installed in a vault).
1910.305(j)(5)(v)	1910.305(j)(5)(v)	No substantive change.
1910.305(j)(5)(vi)	1910.305(j)(5)(vi)	No substantive change.
1910.305(j)(5)(vii)	1910.305(j)(5)(vii)	No substantive change.
1910.305(j)(5)(viii)	1910.305(j)(5)(viii)	No substantive change.
1910.305(j)(6)(i)	1910.305(j)(6)(i)	No substantive change.
1910.305(j)(6)(ii), introductory text	1910.305(j)(6)(ii), introductory text	No substantive change.
	1910.305(j)(6)(ii)(A) and (j)(6)(ii)(B)	**Adds requirements to provide disconnecting means of adequate capacity for capacitors operating at more than 600 V.
1910.305(j)(6)(ii)(A)	1910.305(j)(6)(ii)(C)	No substantive change.
1910.305(j)(6)(ii)(B)	1910.305(j)(6)(ii)(D)	No substantive change.
1910.305(j)(7)	1910.305(j)(7)	No substantive change.
§ 1910.306 Specific purpose equipment and installations.	§ 1910.306 Specific purpose equipment and installations.	
1910.306(a)(1)	1910.306(a)(1)(i), (a)(2)(i), and (a)(2)(ii).	**Reorganized and clarified the requirements for disconnecting means for signs. The final rule does not apply these requirements to exit signs.
	1910.306(a)(1)(ii)	**Adds a requirement for the disconnects for signs located within fountains to be at least 1.52 m from the fountain wall.
1910.306(a)(2)	1910.306(a)(2)(iii)	No substantive change.
1910.306(b), introductory text	1910.306(b), introductory text	No substantive change.
1910.306(b)(1)(i)	1910.306(b)(1)	**Adds specific requirements for the type and location of disconnecting means for runway conductors.
1910.306(b)(1)(ii)	1910.306(b)(2)	No substantive change. (The final rule reorganizes these requirements).
1910.306(b)(2)	1910.306(b)(3)	No substantive change.
1910.306(b)(3)	1910.306(b)(4)	No substantive change.
1910.306(c)	1910.306(c), introductory text	**This paragraph now covers wheelchair lifts, and stairway chair lifts.
1910.306(c)(1)	1910.306(c)(1)	No substantive change.
1910.306(c)(2)	1910.306(c)(8)	No substantive change.
1910.306(c)(3)	1910.306(c)(2)	No substantive change.
	1910.306(c)(3)	**Adds requirements for the type of disconnecting means.
	1910.306(c)(4)	**Adds requirements for the operation of disconnecting means.
	1910.306(c)(5)	**Adds requirements for the location of disconnecting means.
	1910.306(c)(6)	**Adds requirements for the identification of disconnecting means.
	1910.306(c)(7)	**Adds requirements for disconnecting means for single car and multicar installations supplied by more than one source.
	1910.306(c)(9)	**Adds requirements for warning signs for interconnected multicar controllers.
	1910.306(c)(10)	**Adds exceptions related to the location of motor controllers.
1910.306(d)(1)	1910.306(d)(1)	**Adds requirements for the type and rating of the disconnecting means.
1910.306(d)(2)	1910.306(d)(2)	Clarifies that a supply circuit switch may be used as a disconnecting means if the circuit supplies only one welder.
1910.306(e)	1910.306(e)	**Adds a requirement to group the disconnecting means for the HVAC systems serving information technology rooms with the disconnecting means for the information technology equipment. The final rule exempts integrated electrical systems covered by § 1910.308(g). (The existing standard refers to this equipment as data processing equipment).
1910.306(f), introductory text	1910.306(f), introductory text	**Adds coverage of X-rays for dental or medical use.
1910.306(f)(1)(i)	1910.306(f)(1)(i)	No substantive change.
1910.306(f)(1)(ii)	1910.306(f)(1)(ii)	No substantive change.
1910.306(f)(2)(i)	1910.306(f)(2)(i)	No substantive change.
1910.306(f)(2)(ii)	1910.306(f)(2)(ii)	No substantive change.
1910.306(g)(1)	1910.306(g), introductory text	No substantive change.
1910.306(g)(2)(i)	1910.306(g)(1)(i)	No substantive change.
1910.306(g)(2)(ii)	1910.306(g)(1)(ii)	No substantive change.
1910.306(g)(2)(iii)	1910.306(g)(1)(iii)	**Adds a requirement for the installation of doors or detachable panels to provide access to internal parts. Adds a requirement that detachable panels not be readily removable.
1910.306(g)(2)(iv)	1910.306(g)(1)(iv)	No substantive change.
1910.306(g)(2)(v)	1910.306(g)(1)(v)	No substantive change. (Individual requirements are placed in separate paragraphs).
1910.306(g)(2)(vi)	1910.306(g)(1)(vi)	**Adds a requirement to ensure adequate rating of disconnecting means. The final rule also clarifies when the supply circuit disconnecting means may be used as the disconnecting means for induction and dielectric heating equipment.

DISTRIBUTION TABLE—Continued

OLD—section	NEW—section	Description of changes and rationale
1910.306(g)(3)	1910.306(g)(2)	No substantive change. (Individual requirements are placed in separate paragraphs).
1910.306(h)(1)	1910.306(h), introductory text	No substantive change.
1910.306(h)(2)	1910.399	No substantive change.
1910.306(h)(3)	1910.306(h)(1)	No substantive change.
1910.306(h)(4)(i) and (h)(4)(ii)	1910.306(h)(2)	No substantive change. (The two provisions are combined into one paragraph).
1910.306(h)(5)(i)	1910.306(h)(3)(i)	No substantive change.
1910.306(h)(5)(ii)	1910.306(h)(3)(ii)	No substantive change.
1910.306(h)(6)(i)	1910.306(h)(4)(i)	**Adds requirements limiting primary and secondary voltage on isolating transformers supplying receptacles for ungrounded cord- and plug-connected equipment. Also, adds requirement for overcurrent protection for circuits supplied by these transformers.
1910.306(h)(6)(ii)	1910.306(h)(4)(ii)	No substantive change.
1910.306(h)(6)(iii)	1910.306(h)(4)(iii)	No substantive change. (Individual requirements are placed in separate paragraphs).
1910.306(h)(7)(i) and (h)(7)(ii)	1910.306(h)(5)(i)	No substantive change.
1910.306(h)(7)(iii)	1910.306(h)(5)(ii)	No substantive change.
1910.306(h)(7)(iv)	1910.306(h)(5)(iii)	No substantive change.
1910.306(h)(8)	1910.306(h)(6)	No substantive change.
1910.306(h)(9)	1910.306(h)(7)	No substantive change.
1910.306(i)(1)	1910.306(i)(1)	No substantive change.
1910.306(i)(2)	1910.306(i)(2)	**Allows the disconnecting means for a center pivot irrigation machine to be located not more than 15.2 m (50 ft) from the machine if the disconnecting means is visible from the machine. (Individual requirements are placed in separate paragraphs).
1910.306(j)(1)	1910.306(j), introductory text	**Clarifies that hydro-massage bathtubs are covered by this paragraph.
1910.306(j)(2)(i)	1910.306(j)(1)(i)	No substantive change.
	1910.306(j)(1)(ii)	**Extends the boundary within which receptacles require ground-fault circuit interrupter protection from 4.57 m (15 ft) to 6.08 m (20 ft) for new installations.
	1910.306(j)(1)(iii)	**Adds requirements for the installation of at least one receptacle near permanently installed pools at dwelling units.
1910.306(j)(2)(ii)(A)	1910.306(j)(2)(i)	**Clarifies that ceiling suspended (paddle) fans are covered by this requirement.
1910.306(j)(2)(ii)(B)	1910.306(j)(2)(ii)	No substantive change.
1910.306(j)(3)	1910.306(j)(3)	No substantive change.
1910.306(j)(4)(i)	1910.306(j)(4)(i)	No substantive change.
1910.306(j)(4)(ii)	1910.306(j)(4)(ii)	No substantive change.
	1910.306(j)(4)(iii)	**Adds a requirement to guard lighting fixtures facing upward.
1910.306(j)(5)	1910.306(j)(5)	No substantive change.
	1910.306(k)	**Adds requirements for carnivals, circuses, fairs, and similar events.
§ 1910.307 Hazardous (classified) locations.	§ 1910.307 Hazardous (classified) locations.	
1910.307(a)	1910.307(a)	**Adds the Zone classification system for Class I locations. (See detailed discussion later in this section of the preamble).
	1910.307(b)	**Adds documentation requirements for hazardous locations classified using either the division or zone classification system. (See detailed discussion later in this section of the preamble).
1910.307(b), introductory text	1910.307(c), introductory text	No substantive change.
1910.307(b)(1)	1910.307(c)(1)	No substantive change.
1910.307(b)(2)(i)	1910.307(c)(2)(i)	No substantive change.
1910.307(b)(2)(ii), introductory text	1910.307(c)(2)(ii), introductory text	No substantive change.
1910.307(b)(2)(ii)(A)	1910.307(c)(2)(ii)(A)	No substantive change.
1910.307(b)(2)(ii)(B)	1910.307(c)(2)(ii)(B)	**Also permits fixtures approved for Class II, Division 2 locations to omit the group marking.
1910.307(b)(2)(ii)(C)	1910.307(c)(2)(ii)(C)	No substantive change.
1910.307(b)(2)(ii)(D)	1910.307(c)(2)(ii)(D)	No substantive change.
	1910.307(c)(2)(ii)(E)	**Adds a requirement that electric equipment suitable for an ambient temperature exceeding 40 °C (104 °F) be marked with the maximum ambient temperature.
1910.307(b)(3)	1910.307(c)(3)	No substantive change.
1910.307(b)(3), Note	1910.307(c)(3), Note	The last sentence of the note is removed to make it clear that the OSHA standard does not incorporate the National Electrical Code by reference. The NEC continues to be a guideline that employers may reference in determining the type and design of equipment and installations that will meet the OSHA standard.
1910.307(c)	1910.307(d)	No substantive change.
1910.307(d)	1910.307(e)	No substantive change.

DISTRIBUTION TABLE—Continued

OLD—section	NEW—section	Description of changes and rationale
	1910.307(f)	**The final rule adds a list of specific protective techniques for electrical installations in hazardous locations classified under the division classification system.
	1910.307(g)	**Adds the zone classification system as an alternative method of installing electric equipment in hazardous locations. This paragraph sets the protective techniques and other requirements necessary for safe installation of electric equipment in hazardous locations classified under the zone classification system. (See detailed discussion later in this section of the preamble).
§ 1910.308 Special systems	§ 1910.308 Special systems.	
1910.308(a), introductory text	1910.308(a), introductory text	No substantive change.
1910.308(a)(1)(i)	1910.308(a)(1)(i) and (a)(3)(ii)	**Adds the following wiring methods to those acceptable for installations operating at more than 600 V: Electrical metallic tubing, rigid nonmetallic conduit, busways, and cable bus. The proposal also removes the specific requirement to support cables having a bare lead sheath or a braided outer covering in a manner to prevent damage to the braid or sheath. This hazard is covered by § 1910.303(b)(1) and (b)(8)(i) and new § 1910.308(a)(4).
1910.308(a)(1)(ii)	1910.308(a)(1)(ii)	No substantive change.
	1910.308(a)(2) and (a)(3)(i)	** Adds requirements to ensure that high-voltage cables can adequately handle the voltage stresses placed upon them and to ensure that any coverings are flame retardant.
	1910.308(a)(4)	**Adds requirements for the protection of high-voltage cables against moisture and physical damage where the cable conductors emerge from a metal sheath.
1910.308(a)(2)(i)	1910.308(a)(5)(i)	No substantive change.
	1910.308(a)(5)(ii)	**Adds requirements for fuses to protect each ungrounded conductor, for adequate ratings of fuses installed in parallel, and for the protection of employees from power fuses of the vented type.
1910.308(a)(2)(ii)	1910.308(a)(5)(iii)	**Clarifies that distribution cutouts are not suitable for installation in buildings or transformer vaults.
	1910.308(a)(5)(iv)	**Adds requirements for fused cutouts to either be capable of interrupting load current or be supplemented by a means of interrupting load current. In addition, a warning sign would be required for fused cutouts that cannot interrupt load current.
	1910.308(a)(5)(v)	**Adds a requirement for guarding nonshielded cables and energized parts of oil-filled cutouts.
	1910.308(a)(5)(vi)	**Adds requirements to ensure that load interrupting switches will be protected against interrupting fault current and to provide for warning signs for backfed switches.
1910.308(a)(2)(iii)	1910.308(a)(5)(vii)	No substantive change.
1910.308(a)(3)	1910.308(a)(6)	No substantive change.
1910.308(a)(4)(i)	1910.308(a)(7), introductory text	No substantive change.
1910.308(a)(4)(ii)	1910.308(a)(7)(i) and (a)(7)(iii)	No substantive change. (Individual requirements are placed in separate paragraphs).
	1910.308(a)(7)(ii)	**Clarifies that multiconductor portable cable may supply mobile equipment.
1910.308(a)(4)(iii)	1910.308(a)(7)(iv) and (a)(7)(v)	No substantive change. (Individual requirements are placed in separate paragraphs).
	1910.308(a)(7)(vi)	**Limits the conditions under which switch or contactor enclosures may be used as junction boxes or raceways.
1910.308(a)(4)(iv)	1910.308(a)(7)(vii)	No substantive change.
1910.308(a)(4)(v)	1910.308(a)(7)(viii)	No substantive change.
1910.308(b)(1)	1910.308(b), introductory text	No substantive change.
1910.308(b)(2)	1910.308(b)(1)	No substantive change.
1910.308(b)(3)	1910.308(b)(2)	**Clarifies that emergency illumination includes all required means of egress lighting, illuminated exit signs, and all other lights necessary to provide required illumination.
	1910.308(b)(3)	**Adds requirements to provide signs indicating the presence and location of on-site emergency power sources under certain conditions.
1910.308(c)(1), introductory text	1910.308(c)(1), introductory text	No substantive change.
1910.308(c)(1)(i), (c)(1)(ii), and (c)(1)(iii).	1910.308(c)(1)(i), (c)(1)(ii), and (c)(1)(iii).	**Clarifies the power limitations of Class 1, 2, and 3 remote control, signaling, and power-limited circuits based on equipment listing.
1910.308(c)(2)	1910.308(c)(2)	No substantive change.
	1910.308(c)(3)	**Adds requirements for the separation of cables and conductors of Class 2 and Class 3 circuits from cables and conductors of other types of circuits.
1910.308(d)(1)	1910.308(d)(1)	No substantive change.
1910.308(d)(2), introductory text	1910.308(d)(2), introductory text	No substantive change.
1910.308(d)(2)(i)	1910.308(d)(2)(i)	No substantive change.

DISTRIBUTION TABLE—Continued

OLD—section	NEW—section	Description of changes and rationale
1910.308(d)(2)(ii)	1910.308(d)(2)(ii)	**Adds a requirement for power-limited fire alarm circuit power sources to be listed and marked as such.
1910.308(d)(3)	1910.308(d)(3)(i)	No substantive change.
1910.308(d)(4)	1910.308(d)(3)(ii), (d)(3)(iii), and (d)(3)(iv).	**Clarifies the requirements for installing power-limited fire-protective signaling circuits with other types of circuits. (Individual requirements are placed in separate paragraphs).
1910.308(d)(5)	1910.308(d)(4)	No substantive change.
1910.308(e)(1)	1910.308(e), introductory text	No substantive change.
1910.308(e)(2)	1910.308(e)(1)	**Clarifies the requirement for listed primary protectors to make it clear that circuits confined within a block do not need protectors.
1910.308(e)(3)(i)	1910.308(e)(2)(i) and (e)(2)(ii)	No substantive change.
1910.308(e)(3)(ii)	1910.308(e)(2)(iii)	No substantive change.
1910.308(e)(3)(iii)	1910.308(e)(2)(iv)	No substantive change.
1910.308(e)(4)	1910.308(e)(3)	No substantive change.
1910.308(e)(5)	1910.308(e)(4)	No substantive change.
	1910.308(f)	**Adds requirements to separate conductors of solar photovoltaic systems from conductors of other systems and to provide a disconnecting means for solar photovoltaic systems.
	1910.308(g)	**Adds an exception to the provisions on the location of overcurrent protective devices for integrated electrical systems.

Note to table:
**These new and revised provisions are included in the 2000 and 2004 editions of NFPA 70E standard. The NFPA 70E Committee believes that these provisions, which were taken from the 1999 and 2002 NEC, respectively, are essential to employee safety. OSHA agrees with the consensus of NFPA's expert opinion that these requirements are reasonably necessary to protect employees and has included them in the final rule. On occasion, OSHA has rewritten the provision to lend greater clarity to its requirements. However, these editorial changes to the language of NFPA 70E do not represent substantive differences. NFPA's handling of these provisions and the rationale underpinning them is a matter of public record for the NEC and NFPA 70E and is part of the record for this rulemaking (Exs. 2–9 through 2–18). OSHA agrees with the rationale in this record as it pertains to the new and revised provisions the Agency is adopting.

F. General Requirements (§ 1910.303)

Paragraph (b) of proposed § 1910.303 contained a general requirement for electric equipment to be free of recognized hazards likely to cause death or serious physical harm to employees. This provision also contained criteria for judging the safety of electric equipment. One of the criteria was suitability for installation and use in accordance with Subpart S, and a note following paragraph (b)(1)(i) indicated that listing or labeling by a nationally recognized testing laboratory could be evidence of suitability.

The National Multihousing Council recommended adding a second note to this paragraph to indicate that nothing in this provision was to be taken as a directive that limits a local jurisdiction's authority to amend the adopted electrical code (Ex. 4–20).

Local electrical inspection authorities have jurisdiction over public safety as well as employee safety and this jurisdiction is not preempted by OSHA standards. OSHA does not believe that a note to the standard is necessary to clarify this authority. Indeed, the recommended note might serve to confuse employers and employees, leading them to believe that OSHA might enforce those local requirements. Therefore, § 1910.303(b)(1)(i) in the final standard does not include such a note.

In paragraph (g) of proposed § 1910.303, OSHA would have required the employer to maintain sufficient access and working space about electric equipment to permit ready and safe operation and maintenance of equipment. This paragraph would have required the access and working space to meet certain minimum dimensions. One commenter expressed concern regarding the physical space about electric equipment on ships (Ex. 3–7). This commenter argued that, in shipbuilding and repair, the limited space on a ship is a design concern for shore-based equipment. He stated that some shore-based electric equipment is placed in locations that ensure safe access to disconnect switches in the event of an emergency or routine connection of other equipment and that the working space in these locations can be limited. However, he stated that his company deenergizes and removes shore-based equipment before servicing or maintenance.

OSHA believes that this commenter's installation complies with final § 1910.303(g). The introductory text to paragraph (g)(1) contains the general requirement that sufficient access and working space shall be provided and maintained about all electric equipment to permit ready and safe operation and maintenance of such equipment. These provisions ensure that employees maintaining electric equipment while it is energized have enough room to work without danger of contacting energized parts and grounded parts or two circuit parts energized at different potentials simultaneously. The specific dimensions required by paragraph (g)(1)(i) apply only to equipment likely to require examination, adjustment, servicing, or maintenance while it is energized. As long as the employer implements, communicates, and enforces a policy to ensure that the equipment is deenergized before employees engage in any of these tasks that might expose them to contact with energized parts, paragraph (g)(1)(i) does not apply, and the equipment need not provide the specific amount of working space required by that provision. In the commenter's case, the employer not only deenergizes the equipment but removes it from the space in question altogether, thus providing an additional measure of safety. On the other hand, if the equipment were not deenergized, then employees would not be able to work on the equipment safely.

Table S–3 and § 1910.303(h)(5)(v) in the proposed rule would have required a minimum elevation of 2.8 m (9.0 ft) for unguarded live parts operating at 601 to 7500 V and located above working space. A note following proposed Table S–3 permitted the minimum elevation to be 2.6 m (8.5 ft) for installations built before the effective date of the final standard. However, Table S–3 in the existing standard provides for a minimum elevation of 2.4 m (8.0 ft) for

installations built before April 16, 1981, if the voltage is in the range of 601 to 6600 V. OSHA unintentionally omitted this exception for older installations from the footnote to Table S–3 in the proposal. The Agency does not intend for installations made before April 16, 1981, to be modified to provide an additional 0.2 m (0.5 ft) of elevation. Therefore, the Agency is carrying forward the language from the existing standard allowing for the reduced minimum elevation for those older installations.

G. Branch Circuits—Identification of Multiwire Branch Circuits

Identification requirements. Paragraph (b)(1) of final § 1910.304 adds requirements for identification of multiwire branch circuits. The rule requires that all ungrounded conductors of multiwire branch circuits in a building be identified, where accessible, by phase and system where more than one nominal voltage system exists. It goes on to add that the identification means shall be permanently posted at each branch circuit panelboard. For example, the identification means can be color coding, marking tape, or tagging.

For instance, a building served by both 208Y/120-volt and 480Y/277-volt multiwire branch circuits must use a wiring identification means. One method of meeting final § 1910.304(b)(1) would be to use a color-coded scheme with brown, orange, and yellow insulation for the 480-volt system's phase conductors and black, red, and blue insulation for the 208-volt system's phase conductors. A legend, which may include other information such as the panelboard identification, must be permanently affixed at each branch circuit panelboard to identify the respective phase and system color-coding scheme.

One commenter requested clarification of the term ''where accessible'' used in § 1910.304(b)(1) of the proposed rule (Ex. 4–14). He questioned whether the identification means must be posted at each pull and junction box. He suggested allowing a color-coding scheme identified in the employer's written electrical safety program.

OSHA believes that the typical means of complying with this provision, which was ultimately taken from 1999 NEC Section 210–4(d),[13] will be to use conductors with insulation of different colors for each system and post a legend identifying which colors are used with which systems at each panelboard. The color-coded conductors for each circuit are visible at each pull and junction box, which are locations where the conductors are accessible; thus, the employees can determine the voltage on a circuit and at utilization equipment or devices such as motors or receptacle outlets by referring to the legend at the panelboard supplying the circuit. Final § 1910.304(b)(1) requires the legend to be posted at the panelboard for each branch circuit, not at the pull and junction boxes.

The requirements proposed in § 1910.304(b)(1) and (b)(3) for ungrounded conductors of systems of different voltages to be identified were very similar. Proposed paragraph (b)(1) would have required identification of multiwire branch circuits [14] only, whereas paragraph (b)(3) would have required identification regardless of whether a circuit was a multiwire circuit. Paragraph (b)(1) was taken from NFPA 70E–2000 Section 2–2.1, and paragraph (b)(3) was taken from NFPA 70E–2000 Section 2–2.3 (Ex. 2–2). In addition, both NFPA sections are taken from 1999 NEC Section 210–4(d). Proposed paragraph (b)(3) inadvertently omitted language from the NFPA standard (Section 2–2.3) restricting its application to multiwire circuits. Although no one submitted comments on this problem, OSHA has decided to correct this error by not carrying proposed § 1910.304(b)(3) into the final rule.

H. Branch Circuits—Ground-Fault Circuit-Interrupters for Employees

Introduction. Each year many employees suffer electric shocks while using portable electric tools and equipment. The nature of the injuries ranges from minor burns to electrocution. Electric shocks produced by alternating currents (ac) at power line frequency passing through the body of an average adult from hand to foot for 1 second can cause various effects, starting from a condition of being barely perceptible at 1 milliampere to loss of voluntary muscular control for currents from 9 to 25 milliamperes. The passage of still higher currents, from 75 milliamperes to 4 amperes, can produce ventricular fibrillation of the heart; and, finally, immediate cardiac arrest at over 4 amperes. These injuries occur when employees contact electrically energized parts. Typically, the frame of a tool becomes accidentally energized because of an electrical fault (known as a ground fault) that provides a conductive path to the tool casing. For instance, with a grounded electric supply system, when the employee contacts the tool casing, the fault current takes a path through the employee to an electrically grounded object. The amount of current that flows through an employee depends, primarily, upon the resistance of the fault path within the tool, the resistance of the path through the employee's body, and the resistance of the paths, both line side and ground side, from the employee back to the electric power supply. Moisture in the atmosphere can contribute to the electrical fault by enhancing both the conductive path within the tool and the external ground path back to the electric power supply. Dry skin can have a resistance range of anywhere from about 500 to 500,000 ohms and wet skin can have a resistance range of about 200 to 20,000, depending on several factors, such as the physical characteristics and mass of the employee. More current will flow if the employee is perspiring or becomes wet because of environmental conditions. If the current is high enough, the employee will suffer a ground-fault electrocution.

One method of protection against injuries from electric shock is the ground-fault circuit-interrupter (GFCI). This device continually monitors the current flow to and from electric equipment. If the current going out to the protected equipment differs by approximately 0.005 amperes (5-milliamperes) from the current returning, then the GFCI will deenergize the equipment within as little as 25 milliseconds, quickly enough to prevent electrocution.

GFCI requirements. Paragraph (b)(3) of final § 1910.304 sets new requirements for ground-fault circuit-interrupter protection of receptacles and cord connectors used in general industry. Paragraph (b)(3)(i) requires ground-fault circuit protection for all 125-volt, single-phase, 15- and 20-ampere receptacles installed in bathrooms and on rooftops. As noted earlier, this provision only applies to installations made after the effective date of the final rule. Cord sets and cord- and plug-connected equipment in these locations can get wet and expose employees to severe

[13] Section 210–4(d) of the 1999 NEC reads as follows:

(d) *Identification of Ungrounded Conductors.* Where more than one nominal voltage system exists in a building, each ungrounded conductor of a multiwire branch circuit, where accessible, shall be identified by phase and system. This means of identification shall be permitted to be by separate color coding, marking tape, tagging, or other approved means and shall be permanently posted at each branch-circuit panelboard.

[14] A multiwire branch circuit is a branch circuit that consists of two or more ungrounded conductors that have a voltage between them and a grounded conductor that has equal voltage between it and each ungrounded conductor of the circuit and that is connected to the neutral or grounded conductor of the system.

ground-fault hazards. The NFPA 70E Technical Committee believes, and OSHA agrees, that using 125-volt, 15- and 20-ampere cord- and plug-connected equipment in these locations exposes employees to great enough risk of ground-fault electrocution (as noted earlier) to warrant the protection afforded by GFCIs.[15]

Paragraph (b)(3)(ii) of final § 1910.304 requires GFCI protection for all receptacle outlets on temporary wiring installations that are used during maintenance, remodeling, or repair of buildings, structures, or equipment, or during similar construction-like activities.[16] Such activities include cleanup, disaster remediation, and restoration of large electrical installations.

OSHA currently requires GFCI protection for 120-volt, single-phase, 15- and 20-ampere temporary receptacle outlets used on construction sites (§ 1926.404(b)(1)). In the 28 years that this requirement has been in effect, the Agency estimates that between about 650 and 1,100 lives have been saved because of it.[17] Temporary wiring associated with construction-like activities in general industry exposes employees to the same ground-fault hazards as those associated with temporary receptacle outlets on construction sites. In § 1910.304(b)(3)(ii), OSHA is extending the ground-fault protection requirement to temporary receptacles used in construction-like activities performed in general industry. At the same time, this final rule extends protection to temporary wiring receptacles of higher voltage and current ratings (such as 125-volt, single-phase, 30-ampere and 480-volt, three-phase receptacles). It better protects employees from ground-fault hazards than the construction rule because it covers other equipment that is just as subject to damage as 120-volt, single-phase, 15- and 20-ampere equipment and that is more prevalent today than when the construction rule was promulgated over 28 years ago.

The Agency had proposed not to permit the NFPA 70E ''Assured Grounding Program'' as an alternative to GFCIs in this rule. NFPA 70E's Assured Grounding Program, differs in several important respects from the assured equipment grounding conductor program in OSHA's construction standards (§ 1926.404(b)(1)). For example, NFPA 70E permits the Assured Grounding Program as an alternative to GFCI protection for personnel (1) for 125-volt, single-phase, 15- and 20-ampere receptacle outlets in industrial establishments only, with conditions of maintenance and supervision that ensure that only qualified personnel are involved, and (2) for receptacle outlets rated other than 125 volts, single-phase, 15, 20, or 30 amperes. The OSHA construction rule recognizes an assured equipment grounding conductor program as an alternative to GFCIs without restriction. Additionally, under its Assured Grounding Program, NFPA 70E requires electric equipment to be tested only when there is evidence of damage. This is in contrast to the assured equipment grounding conductor program required by OSHA's construction standard, which requires electric equipment to be tested after any incident that can reasonably be suspected to have caused damage.

During the development of the proposal, OSHA had considered including NFPA 70E's Assured Grounding Program or the construction standard's assured equipment grounding conductor program requirements as alternatives to GFCIs, but rejected them. In the preamble to the proposal, OSHA gave the following reasons for rejecting NFPA's Assured Grounding Program: (1) The differences between the general industry and construction requirements would have been too confusing for employers who are subject to both standards, and (2) the NFPA alternative would offer less protection for employees than the assured equipment grounding conductor program in OSHA's construction standard. Additionally, OSHA reasoned in the proposal that requiring GFCIs alone, without even the construction standard's assured equipment grounding conductor program as an alternative, would provide better protection for employees. The construction standard's assured equipment grounding conductor program demands constant vigilance on the part of employees to provide them with the same level of protection as GFCIs. Under that program, employers must perform rigorous inspections and tests of cord sets and cord- and plug-connected equipment generally at 3-month intervals and employees must inspect them daily. In contrast, GFCIs constantly monitor the circuit for ground faults and open the circuit when ground-fault current becomes excessive without the need for either the employer or the employee to take action. Because three fourths of all electrical accidents are caused by poor work practices (55 FR 31986), OSHA believes that GFCIs are a more reliable method of protecting employees.

OSHA received several comments generally supportive of the proposed requirement for GFCIs for 125-volt, single-phase, 15- and 20-ampere receptacles installed in bathrooms or on rooftops and for all 125-volt, single-phase, 15-, 20-, and 30-ampere receptacle outlets that are not part of the permanent wiring of the building or structure and that are in use by personnel (Exs. 3–5, 3–6, 3–10, 4–9, 4–23, 4–24). For example, the American Society of Safety Engineers (ASSE) supported the new requirements for GFCI protection of receptacles and cord connectors and for temporary wiring installations, stating that this is an important aspect of the rule (Ex. 3–5). ASSE stated that this requirement will greatly contribute to the rule's effectiveness in saving lives and it is also consistent with OSHA's current requirements in 29 CFR Part 1926 for construction sites. Another commenter supported OSHA's statement in the proposal that GFCIs for temporary wiring installations have been required in the NEC for many years and that the requirement overall does not impose any hardships on employers (Ex. 5–2). One of the commenters agreed that GFCIs provide continuous protection for employees (Ex. 4–9). A comment (Ex. 4–24) from the National Electrical Manufacturers Association (NEMA) stated that GFCIs provide better protection for employees and a safer workplace than the alternate assured equipment grounding conductor program included in OSHA's construction standard. NEMA added that GFCIs provide continuous protection whereas the assured equipment grounding conductor program requires monthly inspection. NEMA recommended that the assured

[15] Part I 2–2.4.1 of NFPA 70E, 2000 edition, requires GFCI protection for all 120-volt, single-phase, 15- and 20-ampere receptacles installed in bathrooms and on rooftops for other than dwelling units.

[16] See also the discussion of the term ''construction-like activities'' under the summary and explanation of final § 1910.305(a)(2), later in this section of the preamble. It should be noted that the discussion of the term ''construction-like activities'' is intended for application only to the use of this term in Subpart S.

[17] In the preamble to the final rule adopting a requirement for GFCIs on construction sites, OSHA estimated that there were between 30 and 45 deaths per year caused by 120-volt ground faults on construction sites, and the Agency determined that nearly all of those deaths could be prevented by the use of GFCI protection or an assured grounding program (41 FR 55701, December 21, 1976). OSHA fatality investigation data indicate that 46 deaths involving 120-volt ground-faults in temporary wiring occurred over the years 1990 to 1996 (the latest year for which data are complete). This is a death rate of only 6.6 per year. Thus, OSHA believes that the rule has saved between 23 and 39 lives per year or, over the 28 years the rule has been in effect, a total of between about 650 and 1,100 lives.

equipment grounding program not be added as an alternative to GFCIs in the general industry electrical installation standard.

Other commenters opposed OSHA's proposal not to include the assured grounding program as an alternative to GFCIs (Exs. 3–3, 3–6, 3–10, 4–11, 4–14, 4–19, 4–23). Some of them hinted that GFCI-type receptacles and circuit breakers at voltages above 125 volts, 15, 20, and 30 amperes may require constant attention because of nuisance tripping (Exs. 3–6, 3–10, 4–11, 4–19, 4–23). They added that it is possible and likely that construction-type portable equipment used in industry will trip GFCIs during normal operation. For example, Mike Johnson of International Paper argued that portable welding units for the repair of major pieces of equipment such as industrial boilers and other massive pieces of equipment pose a real concern (Ex. 3–6). He noted that the cord sets on such portable equipment are typically heavier and less prone to damage than cords furnished with 125-volt equipment. He further noted his experience with tripping of GFCIs during the normal use of hermetic compressors, which are used for temporary cooling of personnel. Some of those objecting to the omission of the assured equipment grounding conductor program alternative argued that to avoid nuisance tripping on circuits of more than 125 volts, they would be forced to keep circuits very short beyond the location of the GFCI protection (Exs. 4–11, 4–19). Another commenter, Alcoa, supported the use of GFCI protection for all temporary 125-volt, single-phase wiring, including the use of extension cord sets, but did not support the use of GFCI protection on 480-volt, three-phase extension cord sets or 480-volt temporary wiring (Ex. 4–14). Finally, some commenters argued that the lack of commercially available GFCIs at voltages higher than 125 volts makes it impossible to comply with § 1910.304(b)(4)(ii) as proposed (Exs. 4–11, 4–19, 4–23).

These commenters gave three reasons why the Agency should permit an assured equipment grounding conductor program as an alternative to GFCIs, particularly at voltages higher than 125 volts: (1) Because, they asserted, the assured equipment grounding conductor program is equally effective; (2) because of tripping caused by (a) the inherently high leakage current for some electric equipment or (b) the capacitive leakage on long circuits of voltages over 125 volts; and (3) because GFCIs are not available for all branch-circuit voltage and current ratings.

Nothing in the record has convinced the Agency that its preliminary conclusion that GFCIs are more effective protection than the assured equipment grounding conductor program is incorrect. In fact, the 2002 NEC, which permits its assured equipment grounding conductor program as an alternative to GFCIs only in very limited circumstances,[18] indicates that NFPA has reached the same conclusion. OSHA disagrees with the commenters' assertion that the assured equipment grounding conductor program provides protection equivalent to GFCIs. Thus, the Agency has determined based on the record that GFCIs are a more effective means of protecting employees than the assured equipment grounding conductor program.

The Agency cannot determine whether the commenters concerns about tripping caused by capacitive charging currents between the circuit conductors and the equipment grounding conductor at voltages over 125 volts are valid. For multiphase circuits, capacitive currents should balance out across the phases. Even on single-phase circuits, employers should be able to control leakage and capacitive currents by limiting the length of the conductors between the GFCI and the utilization equipment.

However, OSHA recognizes the limited availability of GFCIs for circuits operating at voltages above 125 volts to ground. Consequently, it would be very difficult, if not impossible, for employers to comply with a requirement for GFCI protection for all branch-circuit ratings. For this reason, OSHA has decided to permit an assured equipment grounding conductor program as an alternative to GFCIs when approved GFCIs are unavailable for the voltage and current rating of the circuit involved. However, the final rule does require employers to provide GFCI protection whenever these devices are available at the branch-circuit rating involved. The Agency anticipates that approved 1-, 2-, and 3-pole GFCIs for branch-circuits with ratings above 125 volts and 30 amperes will become available in the future. Employers will need to use those new devices for any temporary wiring installed after they do become available. OSHA will continue to monitor developments in this area and inform employers as appropriate of the availability of GFCIs.

Certain equipment designs cause tripping of GFCIs. For example, some motors, due to design or application, have higher leakage current to ground than a GFCI will allow. In other cases, GFCI tripping can result in undesired consequences. For example, the NEC requires GFCI-protected receptacles in garages at residences but allows for a non-GFCI receptacle for large appliances such as a food freezer. If the GFCI trips, the food in the freezer will spoil. An NEC exception to GFCI protection for temporary installations recognizes the incompatibility of these types of equipment on a GFCI-protected circuit and allows the assured equipment grounding conductor program in place of GFCIs under certain circumstances. Another NEC exception allows the assured equipment grounding conductor program for temporary installations where a greater hazard exists if power is interrupted by a GFCI. For example, a motor for a ventilation fan used to exhaust toxins in the atmosphere may not be compatible with GFCI protection. Loss of the fan because of tripping by a GFCI can pose a risk to employee health and safety. However, OSHA believes that even this type of equipment should not be subject to the risks associated with temporary cord- and plug-connected wiring. The Agency believes that hard-wired methods, which avoid the use of a plug-receptacle combination, afford better protection of employees relying on such critical equipment. Because the GFCI requirement applies only to receptacle outlets, employers can avoid having to install GFCIs by wiring the equipment directly to the circuit conductors at an outlet or panelboard.

Many of the commenters supporting the assured grounding alternative recommended that the Agency include an assured equipment grounding conductor program consistent with OSHA's existing requirements in 29 CFR 1926.404(b)(1)(iii) as an alternative to using GFCIs for protection of personnel (Exs. 3–3, 3–5, 3–6). For example, ASSE recommended that OSHA work at harmonizing this program with the assured equipment

[18] NEC Section 527.6 requires electric shock or electrocution protection for personnel using temporary wiring during activities such as construction, remodeling, maintenance, repair, demolition, and the like. GFCI protection or a written assured equipment grounding conductor program must be used to provide this protection. All 125-volt, single-phase 15-, 20-, and 30-ampere receptacle outlets must have GFCI protection except that in industrial establishments only, where only qualified personnel perform maintenance, the assured equipment grounding conductor program is permitted for specific situations. The limitations of the exception in industrial establishments only are for situations in which: (1) Qualified personnel are using equipment that is not compatible, by design, with GFCI protection or (2) a greater hazard exists if power was interrupted by GFCI protection.

For receptacle outlets other than those rated 125 volts, single phase 15, 20, and 30 amperes, personnel protection must be provided by either GFCI protection or a written assured equipment grounding conductor program.

grounding conductor program permitted under OSHA's construction standards (Ex. 3–5). ASSE did concur that OSHA's testing program in the construction standard, which requires testing after any incident that can reasonably be suspected to have caused damage, is preferable to the approach taken in NFPA 70E.

OSHA agrees with these commenters that any assured equipment grounding conductor program in the general industry standards must be consistent with the corresponding construction standard in § 1926.404(b)(1)(iii). The Agency maintains that the assured equipment grounding conductor program in the existing construction standards is more protective than NFPA's assured grounding program. OSHA's construction standard requires testing of all cord sets and receptacles whenever it can reasonably be suspected that an incident may have caused damage to the equipment, whereas the NFPA standard requires testing only if an incident produces evidence of damage. The purpose of the assured equipment grounding conductor program is designed to detect and correct damage to the equipment grounding conductor particularly when it is unseen. Demanding evidence of damage, as NFPA does, partially thwarts that purpose. Therefore, the Agency has brought the assured equipment grounding conductor program from § 1926.404(b)(1)(iii) into this revision of the general industry electrical installation standard. The final rule requires employers to use the assured equipment grounding conductor program whenever approved GFCIs are not available.

Although the assured equipment grounding conductor program in the final rule is consistent with the one in the construction standard, the final rule, unlike the construction standard, does not always permit it to be used as an alternative to GFCIs. The determination that GFCIs are a preferable form of protection and not to permit the assured equipment grounding conductor in all circumstances is based on the public record of this rulemaking. The final rule applies only to general industry and not to construction. OSHA will not enforce this rule for construction work; however, employers are encouraged to use GFCIs in accordance with the general industry standard even when the construction standard applies.

The assured equipment grounding conductor program in the construction standard relies on the definition of ''competent person'' in § 1926.32(f).[19] The assured equipment grounding conductor program in this final rule also requires one or more competent persons for implementation. Consequently, the Agency is bringing the definition of ''competent person'' from OSHA's construction standards into final § 1910.399.

OSHA received numerous comments concerning proposed § 1910.304(b)(4)(ii)(A). The pertinent part of this proposed provision read, ''receptacles on a 2-wire, single-phase portable or vehicle-mounted generator rated not more than 5 kW, where the circuit conductors of the generator are insulated from the generator frame and all other grounded surfaces, are permitted without ground-fault circuit-interrupter protection for personnel.'' This exemption from the GFCI requirement was taken from NFPA 70E–2000.

Several commenters recommended removing this exemption (Exs. 4–13, 4–15, 4–17, 4–18, 4–21). These commenters stated that this exemption has been removed from the most recent editions of the NEC and NFPA 70E. They argued that there was never any technical justification for this provision and, thus, its inclusion in the OSHA standard is unjustified.

OSHA agrees with these comments and has decided to remove this exemption to better align the final rule with the consensus standards. The proposed exemption from the GFCI requirement for portable and vehicle-mounted generators was based on 1999 NEC Section 305–6(a), Exception 1. The exemption in the 1999 NEC and the exemption in proposed § 1910.304(b)(4)(ii)(A) were the same as the exemption for portable and vehicle-mounted generators in OSHA's construction requirement for ground-fault circuit-interrupters (§ 1926.404(b)(1)(ii)). In promulgating the construction standard, OSHA gave the following rationale for exempting these generators from the requirement for GFCI protection:

> On generators whose supply wires are not required to be grounded, and are in fact not grounded, the return path for a ground-fault current to flow is not completed and the hazard which a GFCI would protect against is not present. Consequently, the rule as promulgated in [§ 1926.404(b)(1)(ii)] does not require the use of GFCI's on portable or vehicle-mounted generators of 5kW capacity or less if its output is a two-wire, single-phase system and its circuit conductors are insulated from the generator frame and all other grounded surfaces. [41 FR 55702, December 21, 1976]

The NEC used to require only neutral conductors to be bonded to the generator frame. (See, for example, 1981 NEC Section 250–6.) The NEC now requires single-phase, two-wire circuits to have one circuit conductor bonded to the generator frame. (See Sections 250–26 and 250–34(c) of the 1999 NEC and Sections 250.26 and 250.34(C) of the 2002 NEC.) Thus, the NEC no longer permits generators to be wired so as to meet the conditions in the proposed exemption. That is, because one of the circuit conductors must be bonded to the generator frame, the conductors cannot be ''insulated from the generator frame'' as required by the exemption.

In addition, connecting one conductor on a single-phase, two-wire generator to the generator frame facilitates the operation of a GFCI when a ground fault occurs. Even though the generator frame is not required to be grounded, it frequently is, through direct contact with ground or through grounding-type equipment, which has its equipment grounding conductor connected to the generator frame. Bonding one of the circuit conductors to the generator frame provides a path outside the circuit conductors for ground-fault current to flow. Such current will be detected by a GFCI. If the circuit conductors are insulated from the generator frame, it is more likely that any ground fault current will return through the circuit conductors and go undetected by a GFCI.[20]

For these reasons, OSHA has determined that the exemption from the GFCI requirement for single-phase generators is not warranted and has revised final § 1910.304(b)(3)(ii)(A) (proposed § 1910.304(b)(4)(ii)(A)) accordingly. In addition, the evidence in the record indicates that it is also necessary to revise the generator grounding requirements in final § 1910.304(g)(2) and (g)(3)(iii) to match Sections 250.26 and 250.34(C) of the 2002 NEC, respectively. (See the summary and explanation of these provisions later in this section of the preamble.) Removing the exception from final § 1910.304(b)(3)(ii)(A) without revising the generator grounding provisions would result in a requirement for GFCIs when they would not work as intended to protect employees. Incorporating the NEC

[19] Paragraph (f) of § 1926.32 reads as follows: *Competent person* means one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

[20] For a ground fault to occur on an ungrounded circuit, two faults must be present. If both faults are on the load side of the GFCI, then any leakage current will go undetected.

provisions on generator grounding will work in concert with the GFCI provisions to ensure that employees are adequately protected from ground faults.

OSHA proposed Note 2 to § 1910.304(b)(4)(ii)(A) to read as follows:

> Cord sets and devices incorporating listed ground-fault circuit-interrupter protection for personnel are acceptable forms of protection.

Several commenters suggested that the note be reworded to recognize portable GFCI protection only when it is placed at the end closest to the source of power (Exs. 4–13, 4–15, 4–17, 4–18, 4–21). They argued that GFCI protection should be provided for the entire cord set and that the only way to do so is to put the GFCI at the source of power.[21]

OSHA agrees with these commenters and has revised the note to read:

> Cord sets and devices incorporating the required ground-fault circuit-interrupter that are connected to the receptacle closest to the source of power are acceptable forms of protection.

This language, which was similar to that recommended by these commenters, will provide the most effective protection for employees using temporary wiring. Employers using portable GFCIs to comply with final § 1910.304(b)(3)(ii)(A) must install them at the first receptacle on the circuit (the end closest to the source of power). This will protect employees from faults in all downstream cord sets and equipment.

I. Accessibility of Overcurrent Devices

Proposed § 1910.304(f)(1)(iv) addressed the location of overcurrent devices. The first sentence of this provision would have required overcurrent devices to be accessible ''to each employee or authorized building management personnel.''

OSHA received a request to insert the word ''qualified'' before ''employee'' in that provision (Ex. 4–22). The commenter was concerned that the provision would require every employee at the workplace to have access to overcurrent devices.

This proposed provision is identical to existing § 1910.304(e)(1)(iv) and is consistent with § 240.24 of the 2002 NEC. The wording of this provision permits employers to restrict access to authorized building management personnel. Consequently, the proposed rule does not require access by every employee, and there is no need to revise the language of the rule.

J. Grounding

Proposed § 1910.304(g)(1) listed systems that would have been required to be grounded. Proposed paragraphs (g)(1)(iv) and (g)(1)(v) governed grounded and ungrounded ac systems of 50 to 1000 volts. These two paragraphs were substantively the same as paragraphs (f)(1)(iv) and (f)(1)(v) of existing § 1910.304, except that in the existing rule ac circuits of 480 to 1000 volts are permitted to use a high-impedance grounded neutral in lieu of a neutral with a direct connection to the grounding electrode.

In a joint comment, CHS Inc., and the National Cooperative Refinery Association (NCRA) expressed concern about these provisions (Ex. 4–25). These two companies requested that the Agency consider permitting the operation of three-phase ungrounded delta systems that have been utilized for many years by the refining industry and others for electrical systems. They argued that these systems became popular in the early 20th century because of the need to operate loads without interruption because of the operation of overcurrent protection devices on a short circuit. The comment referenced Soares Book on Grounding published by the International Association of Electrical Inspectors. Quoting this book, the commenter stated that the reason to operate a system in this manner is to ''obtain an additional degree of service continuity. Since the system is ungrounded, the occurrence of the first ground fault (as distinguished from a short circuit) on the system will not cause an overcurrent protective device to open.'' CHS and NCRA further noted that these ungrounded systems are used with ground detection equipment and that trained electrical maintenance personnel investigate and repair problems without causing an abrupt outage.

Electrical systems are grounded primarily to:

(1) Limit overvoltages caused by lightning, line surges, or contact with higher voltage systems;

(2) Stabilize voltage to earth during normal operation; and

(3) Facilitate the operation of overcurrent devices protecting the circuit. (See 1999 NEC Section 250–2.)[22]

An ac system that is connected for ungrounded operation is a system that is connected to ground via the capacitance of the insulating medium, be it air, rubber or thermoplastic insulation. The capacitance-to-ground varies resulting in system operating problems. The line-to-ground voltage is not constant. Such erratic voltage makes ungrounded systems difficult to troubleshoot.

OSHA views these conditions as hazardous to employees working near the power system. A hazard of this type of installation is the possibility for the frame of a piece of equipment to become energized at some voltage above ground. A shock hazard exists if an employee simultaneously touches the equipment and a grounded object such as a handrail.

In general, the NEC and the IAEI Soares Book on Grounding cite very similar if not the same recommendations for grounding of electrical systems, and the final rule parallels these requirements. In fact, contrary to the suggestions made by the commenters, the provisions in question are entirely consistent with the IAEI Soares Book on Grounding. Paragraph (g)(1)(iv) of final § 1910.304 requires delta systems of 50 to 1000 volts[23] to be grounded only if:

(1) They can be grounded so that the maximum voltage to ground on the ungrounded conductors does not exceed 150 volts (that is, a delta system with a phase-to-phase voltage of 150 volts or less),

(2) The system is a three-phase, four-wire delta circuit in which the midpoint of one phase is used as a circuit conductor, or

(3) A service conductor is uninsulated.

OSHA believes that few delta systems meet any of these conditions, in which case the final rule does not require them to be grounded. Even if one of those conditions is met, the circuit may

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[21] The National Electrical Code Handbook for the 2002 NEC, in its explanation of the NEC requirements for GFCI protection for temporary installations, identifies a GFCI device as being designed for insertion at the line, or source, end of a flexible cord set. The short style of cord set shown in the Handbook lends itself to in-series connection with single or multiple, series-connected, cord sets.

[22] Soares Book on Grounding, a recognized reference on grounding to which CHS and NCRA referred, offers a list of known disadvantages of operating ungrounded three-phase ac systems as follows:

Disadvantages of operating systems ungrounded include but are not limited to the following:

1. Power system overvoltages are not controlled. In some cases, these overvoltages are passed through transformers into the premises wiring system. Some common sources of overvoltages include: lightning, switching surges and contact with a high voltage system.

2. Transient overvoltages are not controlled, which, over time, may result in insulation degradation and failure.

3. System voltages above ground are not necessarily balanced or controlled.

4. Destructive arcing burnouts can result if a second fault occurs before the first fault is cleared.

[23] Systems over 1000 volts are covered by final § 1910.304(g)(9), to which CHS and NRCA did not object.

operate using a high-impedance grounded neutral system as permitted by final § 1910.304(g)(1)(v)(E). Such systems provide higher system reliability in a manner similar to ungrounded systems in that a single ground fault triggers alarms on ground-detection equipment instead of causing the circuit protective devices to deenergize the circuit. However, these systems provide better protection against ground faults and overvoltages than do ungrounded systems.

Finally, the provisions to which CHS and NCRA refer are not new requirements. They are in the existing OSHA electrical standard and have been enforced by the Agency since 1972.

For all of these reasons, OSHA believes that grounded systems are a much more reliable method of protecting employees than ungrounded systems and has retained § 1910.304(g)(1)(iv) and (g)(1)(v) as proposed.

For the reasons presented under the summary and explanation of final § 1910.304(b)(3)(ii)(A) (proposed § 1910.304(b)(4)(ii)(A)), earlier in this section of the preamble, OSHA is revising the grounding requirements in Subpart S for consistency with 2002 NEC Sections 250.26 and 250.34(C). This revision is in two parts: A new provision (final § 1910.304(g)(2)) and a revised provision (final § 1910.304(g)(3)(iii), proposed § 1910.304(g)(2)(iii)). Final § 1910.304(g)(2), which had no counterpart in the proposal, adopts requirements from 2002 NEC Section 250.26 specifying which conductor in an ac system must be grounded. This new provision complements final § 1910.303(g)(1), which specifies which systems must be grounded. These two provisions ensure that the voltage to ground on ungrounded conductors is minimized. It should be noted that final § 1910.304(g)(2) requires a system conductor to be grounded only when that system is required to be grounded by § 1910.304(g)(1).

Paragraph (g)(3)(iii) of final § 1910.304 is revised to match 2002 NEC Section 250.34(C). The revised provision requires that any system conductor required to be grounded by final § 1910.304(g)(2) be bonded to the generator frame, which serves as the grounding electrode for the system. This requirement ensures that systems fed by portable and vehicle-mounted generators are wired consistently with service-supplied systems and provide a level of safety equal to that of service-supplied systems.

Proposed § 1910.304(g)(3)(iii) (final § 1910.304(g)(4)(iii)) stated, ''On extensions of existing branch circuits that do not have an equipment grounding conductor, grounding-type receptacles may be grounded to a grounded cold water pipe near the equipment.''

OSHA received several comments on the use of cold water pipes for equipment grounding connections (Exs. 4–4, 4–13, 4–15, 4–17, 4–18, 4–21). For example, Mr. Brooke Stauffer of the National Electrical Contractors Association (NECA) recommended deleting this requirement from the standard, arguing that this method of grounding is not permitted in the 2002 NEC (Ex. 3–2). He noted that Section 250.52 of the NEC states that an interior metal water pipe more than 1.52 meters (5 feet) from the point of entrance of the water pipe into the building is no longer allowed to serve as part of the grounding electrode system. Other comments stated that using an isolated equipment grounding conductor such as a cold water pipe may increase the risk of reactance along the equipment grounding conductor when an ac fault is involved (Exs. 4–4, 4–13, 4–15, 4–17, 4–18, 4–21). For example, one commenter stated that using a water pipe to ground equipment violates 2002 NEC Section 300.3(B), which requires all circuit conductors to be grouped together so magnetic fields are offset and reluctance is minimized (Exs. 4–13, 4–15). He further argued that plastic pipe makes water pipes an unreliable ground and that using water pipes to ground electric equipment can pose hazards to employees working on the piping system, as follows:

> Water pipes cannot be counted upon to serve the same function as an equipment grounding conductor, which is to prevent electrocution due to malfunctioning equipment on the branch circuit by allowing large amounts of current to flow and trip the overcurrent device. The use of water pipes as equipment grounding conductors is actually more likely to cause an electrocution in the event that a plumber, pipe-fitter or similar professional working on the water piping system would break a pipe connection involved in a fault, thereby exposing themselves to the full lethal circuit voltage and providing a path for current to flow. Unlike electrical workers working on branch circuits, there are no specific requirements for plumbers, pipe-fitters or similar professionals to deenergize and lock out electrical circuits in order to work on plumbing systems, nor should there be one.
>
> The advent of current technology and practice of using nonmetallic pipe in all or part of a plumbing system would cause metallic parts of equipment or sections of the water piping to become energized if a tool or equipment were to malfunction and expose anyone (plumber, pipe-fitter, general plant employee) to an electrocution hazard from simple contact with the piping system. [Ex. 4–13]

OSHA agrees with these comments. It is important for the equipment grounding conductor to be reliable and of low impedance. Water pipes are neither. In addition, as noted by this commenter, employees working on water pipes used in this manner can be exposed to hazardous differences in electrical potential across an open pipe. On the other hand, OSHA has allowed grounded cold water pipes to be used for grounding branch circuit extensions since 1972. (See, for example, existing § 1910.304(f)(3)(iii).[24]) Since there have been very few reported accidents, the Agency does not believe that the risk to employees, not to mention the substantial cost to employers, of rerunning these branch circuit extensions is worth the reduction in risk associated with the continued use of water pipes for grounding purposes. To redo a branch circuit extension, an employee would need to deenergize the existing circuit and run new conductors back to a point where an acceptable connection to the ground is available. (Section 250.130(C) of the 2002 NEC lists acceptable grounding points.) The risk of inadvertently contacting an energized part during the recircuiting process is likely to be at least as high as the risk of electric shock caused by using the water pipe as an equipment grounding conductor. Also, it may not be known which branch circuit receptacles are grounded to a water pipe; thus, employees may be introduced to hazards in the process of tracing the existing wiring installation. Consequently, the final rule allows using a grounded cold water pipe as the equipment grounding conductor on branch circuit extensions only in existing installations. The final rule would also require such equipment grounding connections to be replaced any time work is performed on the branch circuit. In such cases, the circuit would need to be deenergized anyway, and there would be no increased risk during the installation of a new equipment grounding conductor.

Proposed § 1910.304(g)(4) (final § 1910.304(g)(5)) would have required the path to ground from circuits, equipment, and enclosures to be permanent and continuous. The language in this proposed provision is identical to existing § 1910.304(f)(4).

[24] The existing standard permits the use of a grounded cold water pipe as an equipment grounding only for extensions of branch circuits that do not have an equipment grounding conductor.

Several commenters recommended adding the word ''effective'' in the requirement to ensure that the grounding path of the conductor is successful in providing a permanent and continuous path to ground (Exs. 4–4, 4–13, 4–15, 4–17, 4–18, 4–21). These commenters noted that the NEC has requirements on effective grounding and has had these requirements in the code for many years and that the proposed rule was inconsistent with the NEC, NFPA 70E, and other OSHA requirements. For example, Mr. Douglas Baxter stated:

> Equipment grounding is important enough for OSHA to require it to be effective as stated in the proposal at these locations:
> Page 17817–1910.304(b)(2)(ii) ''Receptacles and cord connectors having grounding contacts shall have those contacts effectively grounded.''
> Page 17823–1910.305(c)(5) ''Grounding. Snap switches, including dimmer switches, shall be effectively grounded and shall provide a means to ground metal faceplates.''
> It is unclear as to why OSHA believes that electrical circuits and equipment (which would be referenced under 1910.304(g)(4)) somehow will not present an electrocution hazard if not effectively grounded unlike receptacles or snap switches.
> Particularly noteworthy to underscore is the fact that as written in the proposal, 1910.304(g)(4) is not consistent with the 2004 (current) edition of NFPA 70E, nor is it consistent with any edition since the original 1979 Edition. The proposal should read the same as the 2000 edition of NFPA 70E, as shown above. [Ex. 4–17]

OSHA believes that the effectiveness of grounding is important and will save lives when done properly. Therefore, the final rule, in § 1910.304(g)(5), requires the equipment grounding conductor to be permanent, continuous, and effective.

The 2002 edition of NEC defines ''effectively grounded'' in Article 100 as:

> Intentionally connected to earth through a ground connection or connections of sufficiently low impedance and having sufficient current-carrying capacity to prevent the buildup of voltages that may result in undue hazards to connected equipment or to persons.

This same definition appears in Part I of the 2000 edition of NFPA 70E. OSHA proposed a similar definition of ''effectively grounded,'' which would have applied to voltages over 600 volts, nominal. To clarify the final standard and to maintain consistency with the NEC and NFPA 70E, OSHA is adopting the NEC definition of ''effectively grounded'' in § 1910.399 and is applying that definition in the final rule to all voltages. The term ''effectively grounded'' (or the equivalent) is used in final §§ 1910.304(b)(2)(ii), (g)(5), (g)(8)(ii), and (g)(8)(iii), 1910.305(c)(5), and 1910.308(a)(6)(ii), (a)(7)(viii), (e)(4)(ii), and (e)(4)(iii). OSHA believes that the definition adopted in the final rule accurately describes the intent of that term for all of these requirements. The adopted definition merely makes explicit what was implicit in the proposal.

Paragraph (g)(7)(ii) of proposed § 1910.304 (final § 1910.304(g)(8)(ii) and (g)(8)(iii)) would have recognized several methods of grounding electric equipment by means other than direct connection to an equipment grounding conductor. This provision would have permitted, for installations made before April 16, 1981, only, electric equipment to be considered effectively grounded if it was secured to, and in metallic contact with, the grounded structural metal frame of a building. This paragraph is the same as existing § 1910.304(f)(6)(ii).

Several commenters requested that OSHA totally remove the structural metal frame of a building as an acceptable grounding method (Exs. 3–2, 4–13, 4–15, 4–18, 4–21). For example, NECA believed that this grounding technique is obsolete and unsafe (Ex. 3–2). NECA noted that 2002 NEC Section 250.136(A) states: ''The structural metal frame of a building shall not be used as the required equipment grounding conductor for ac equipment.'' Other commenters argued that this allowance is incongruent with the 2004 and prior editions of NFPA 70E (Exs. 4–13, 4–15, 4–18, 4–21). For example, Mr. Michael Kovacic stated that this has been prohibited for ac circuits since the 1978 edition of the NEC. He presented the reason for this as follows:

> This requirement [in proposed paragraph (g)(7)(i) for equipment grounded by an equipment grounding conductor that is contained within the same raceway, cable, or cord, or runs with or encloses the circuit conductors] is to keep conductors grouped close together so magnetic fields generated by the flow of ac electricity, which reacts with the circuit conductors, will cancel each other out, thereby minimizing the total circuit impedance for safety reasons (preventing electrocution in the event of a breakdown or fault in the equipment by rapid operation of the overcurrent device). In the case of dc circuits, there are no pulsating magnetic fields and consequently no circuit reactance, which increases the circuit impedance to negatively affect the grounding path of equipment. [Ex. 4–18]

OSHA agrees with these comments. In fact, the Agency provided similar rationale in prohibiting the use of the metal structure of a building for grounding electric equipment when it adopted the existing standard in 1981 (46 FR 4034, 4046, January 16, 1981). However, at that time, the Agency also decided not to apply this prohibition retroactively, reasoning as follows:

> [F]rom the standpoint of employee safety, installations where electric equipment is secured to, and in metallic contact with, the grounded structural frame of a building are essentially free of electrical shock hazards. This condition occurs because the electric equipment enclosures and the metal building frame will be approximately at the same potential if a ground fault occurs and will provide a measure of employee safety. [46 FR 4046]

In that rulemaking, OSHA agreed with comments that it would be impractical to require changes to installations that had been permitted by the NEC for many years before 1978.

OSHA believes that this rationale continues to apply today. Nothing in the record has convinced the Agency that the conclusion drawn in the existing standard in 1981 is incorrect. Also, the Agency does not believe that the substantial cost to employers of changing these grounding connections is worth the slight possible reduction in risk associated with moving from the use of the structural metal frame of a building to a separate equipment grounding conductor. In addition, in actual practice, such a change might not lead to an overall reduction in risk at all. To reconfigure a branch circuit and run new conductors back to a point where an acceptable connection to the ground is available,[25] an employee would need to deenergize the existing circuits connected. An employee could inadvertently contact an energized part during the recircuiting process.

Consequently, the final rule in § 1910.304(g)(8)(iii) continues to allow the use of the grounded structural metal frame of a building as the equipment grounding conductor for equipment secured to, and in metallic contact with, the metal frame only for installations made before April 16, 1981. However, unlike the existing standard, the final rule requires such grounds to be replaced any time work is performed on the branch circuit. In such cases, the circuit needs to be deenergized anyway, and there would be no increased risk during the installation of a new equipment grounding conductor. Additionally, the costs of installing an acceptable equipment grounding conductor in such cases would be minimized.

[25] Section 250.130(C) of the 2002 NEC lists acceptable grounding methods.

K. Equipment for General Use (§ 1910.305)

Paragraph (a)(2) of proposed § 1910.305 would have applied to temporary wiring installations. According to proposed § 1910.305(a)(2)(iii), temporary installations over 600 volts would only be permitted for periods of tests, experiments, or emergencies.

Northrop Grumman-Newport News objected to this restriction on the use of temporary wiring of more than 600 volts (Ex. 3–7). It noted that employers performing shipbuilding and ship repair use temporary wiring to provide power to the ships that arrive at the shipyard, stating:

> During construction and major overhaul of a vessel, ship and shore-based electrical installations may be interconnected. For instance, permanent ship electrical systems will typically be powered by temporary shore power whenever a ship is not at sea. Ships are specifically designed in this manner. [Ex. 3–7–1]

It noted further that the ships must have their normal power source shut down and use the power source from connection points within the shipyards, which can be more than 600 volts. It stated that flexible cords and cables are used to supply power to these ships for repair and maintenance and that they are temporary wiring installations.

Paragraph (a)(2) of proposed § 1910.305 was taken from Article 305 of the 1999 NEC and section 3–1.2 in Part I of NFPA 70E–2000. Both of these standards permit temporary wiring of more than 600 volts to be used for construction in addition to the uses permitted in the OSHA proposal. The Agency did not include ''construction'' as a permitted use in the proposal (or, for that matter, in the existing standard) because construction work is covered by the construction standards in 29 CFR Part 1926. However, Northrop Grumman-Newport News's comments show that certain types of construction-like activities occur in general industry and maritime. The Agency believes that the NEC and NFPA 70E intend to permit high-voltage temporary wiring installations used for purposes like those described in the Northrop Grumman-Newport News comments. Thus, to permit this type of temporary installation and to improve consistency with the NEC and NFPA 70E, OSHA has added ''construction-like activities'' to the list of permitted uses for high-voltage temporary wiring in final § 1910.305(a)(2)(iii). OSHA intends this term to include such construction-like activities as ship building and ship repair without regard to whether the activity falls under OSHA's construction standards. As noted earlier, construction-like activities also include cleanup, disaster remediation, and restoration of large electrical installations.[26]

Proposed § 1910.305(a)(3)(v) would have permitted nonmetallic cable trays to be installed only in corrosive areas and in areas requiring voltage isolation. Two commenters objected to this provision (Exs. 3–8, 4–16, 4–22). Mr. Mark Spence, representing Dow Chemical Company (Exs. 3–8, 4–16), noted that the corresponding provision in the NEC, section 392.3(E), reads as follows:

> In addition to the uses permitted elsewhere in Article 392, nonmetallic cable tray shall be permitted in corrosive areas and in areas requiring voltage isolation.

He pointed out that section 392.3 specifically permits cable tray systems to be installed as support systems for services, feeders, branch circuits, communications circuits, control circuits, and signaling circuits. Thus, he concluded that the NEC does not restrict the use of nonmetallic cable trays as OSHA's proposal did.

OSHA agrees with Mr. Spence's comments and has not carried proposed § 1910.305(a)(3)(v) into the final rule. This action removes the proposed restriction on the use of nonmetallic cable trays. Under the final rule, nonmetallic cable trays can be used wherever metallic cable trays may be used.

Mr. Spence also objected to the application of proposed § 1910.305(j)(2)(iii) to all installations made after March 15, 1972 (Exs. 3–8, 4–16). This provision would have prohibited nongrounding-type receptacles from being used for grounding-type attachment plugs. He stated that Dow Chemical was concerned that this provision could pose problems with existing buildings with two-wire receptacles. He reasoned as follows:

> This [proposed provision] is adapted from NFPA 70E § 420.10(C)(2), which states:
>
> Non-grounding-type receptacles and connectors shall not accept grounding-type attachment plugs.
>
> * * * * *
>
> OSHA apparently considers that this proposed requirement is implicit in the existing Subpart S. The preamble to the proposed rule refers to this provision as a ''clarification'' (69 Fed. Reg. at 17788). However, the text of existing Subpart S does not address this issue, and Dow could not identify any previous OSHA interpretation of its existing requirements which reached the conclusion articulated in proposed § 1910.305(j)(2)(iii).
>
> Accordingly, OSHA should include this requirement (and all others that are new to Subpart S) in section 1910.302(b)(4), requirements applicable only to installations made after the effective date of the final rule. [Ex. 4–16]

The NEC has required receptacles to be of the grounding type for decades. The 1972 NEC, which was adopted by reference in Subpart S from March 15, 1972, until April 16, 1981, contained many requirements for grounding-type receptacles. For example, Section 210–21(b) of the 1971 NEC required all receptacles on 15- and 20-ampere branch circuits to be of the grounding type. That section also requires grounding-type receptacles to be used as replacements for existing nongrounding-type receptacles unless it was impractical to reach a source of ground. Thus, the vast majority of receptacles installed since 1972 are of the grounding type. In addition, equipment supplied with an equipment grounding conductor is intended to have that conductor properly connected to ground. Using an adapter with such equipment is prohibited by existing § 1910.334(a)(3)(iii) if the adapter interrupts the equipment grounding conductor. Connecting or altering an attachment plug in a manner that prevents proper connection of the equipment grounding conductor is prohibited by existing § 1910.334(a)(3)(ii). Consequently, OSHA's current standards essentially prohibit connecting grounding-type attachment plugs to nongrounding-type receptacles. For these reasons, OSHA is carrying proposed § 1910.305(j)(2)(iii) forward unchanged into the final rule.

Proposed § 1910.305(j)(2)(v) would have required a receptacle installed outdoors in a location protected from the weather to have an enclosure that is weatherproof when the receptacle is covered. A note following that provision indicated that a receptacle is considered to be in a location protected from the weather where it is located under roofed open porches, canopies, marquees, or the like and where it will not be subjected to a beating rain or water runoff. OSHA received several comments on the language in the note (Exs. 3–2, 4–13, 4–17, 4–18, 4–21). These commenters argued that the word ''beating'' is not defined making this provision difficult to enforce. They recommended that OSHA remove this word from the note.

[26] It should be noted that the discussion of the term ''construction-like activities'' applies only to the use of this term in Subpart S.

The Agency is retaining the term ''beating rain'' in the final rule. The language in the note to final § 1910.305(j)(2)(v) mirrors that in section 406.8(A) of the 2002 NEC, which uses the same term in describing ''locations protected from the weather.'' More importantly, OSHA has determined that the word ''beating'' as used in the note is critical to the meaning of the note itself. Paragraph (j)(2)(v) in final § 1910.305 is intended to require weatherproof enclosures to ensure that water does not enter or accumulate within the enclosure.[27] If rain can strike the receptacle face directly, water will almost certainly enter and accumulate within the enclosure. Thus, the term ''beating rain'' as used in the note means a rain that directly contacts the receptacle face. This interpretation is consistent with the definition of ''damp location'' in the final rule.[28]

Proposed § 1910.305(j)(3)(iii) would have required each electric appliance to be provided with a nameplate with the identifying name and the rating in volts and amperes, or in volts and watts. This provision also would have required the marking to include frequency ratings if the appliance is to be used on specific frequencies. Finally, if motor overload protection external to the appliance is necessary, this paragraph would have required the appliance to be so marked.

Dow Chemical Company argued that the requirements to mark appliances when external overload protection is needed and when the appliance must be used on specific frequencies were new requirements that should be made applicable only to new installations built after the publication of the final rule (Exs. 3–8, 4–16). Dow noted that the counterpart in the existing standard, § 1910.305(j)(3)(iii), requires the marking to include only the rating in volts and amperes or volts and watts. They recommended that proposed § 1910.305(j)(3)(iii) be included in the list of requirements applicable only to installations made after the effective date of the final standard.

The requirement for appliances to be marked with any necessary frequency ratings was contained in section 422–30(a) of the 1971 NEC. The requirement for marking of the need for external overload protection was also contained in section 422–30(a) of the 1971 NEC. In addition, the existing OSHA standard in § 1910.303(e) requires electric equipment to be marked with voltage, current, wattage, or other ratings as necessary. The ratings required by the NEC are necessary for the safety of any employee installing or using affected appliances. Thus, the marking provisions proposed in § 1910.305(j)(3)(iii) are not new. The existing rule requires the markings implicitly. The final rule simply makes the requirement explicit. Therefore, OSHA has not added that paragraph to the list of requirements applicable only to new installations given in final § 1910.302(b)(4).

Proposed § 1910.305(j)(4)(ii) would have required that each motor controller be provided with an individual disconnecting means within sight of the controller. However, this provision would have permitted a single disconnecting means to be located adjacent to a group of coordinated controllers mounted adjacent to each other on a multi-motor continuous process machine. In addition, the proposed rule would have permitted the controller disconnecting means for motor branch circuits over 600 volts, nominal, to be out of sight of the controller, if the controller was marked with a warning label giving the location and identification of the disconnecting means to be locked in the open position.

Mr. Mark Spence of Dow Chemical requested that the standard allow disconnecting means for motor controllers of 600 volts, nominal, or less to be out of sight of the controller location if the disconnecting means is capable of being locked out (Exs. 3–8, 4–16). He pointed to an exception to section 430.102(B) of the 2002 NEC, which, under certain conditions, permits disconnecting means to be located out of sight of the motor when the disconnecting means is capable of being locked in the open position.

OSHA has not adopted Dow's recommendation. The proposed rule requires disconnecting means to be located within sight of the motor controller location whereas the NEC exception permits the disconnecting means to be out of sight of the motor, not the controller. The requirement in 2002 NEC section 430.102(A) for the disconnecting means to be within sight of the controller location still exists. Thus, proposed § 1910.305(j)(4)(ii) is consistent with the 2002 NEC, and OSHA is carrying it forward, unchanged, into the final rule.

L. Specific Purpose Equipment and Installations—§ 1910.306

Proposed § 1910.306(e) read as follows:

> A means shall be provided to disconnect power to all electronic equipment in an information technology equipment room. There shall also be a similar means to disconnect the power to all dedicated heating, ventilating, and air-conditioning (HVAC) systems serving the room and to cause all required fire/smoke dampers to close. The control for these disconnecting means shall be grouped and identified and shall be readily accessible at the principal exit doors. A single means to control both the electronic equipment and HVAC system is permitted.

This proposed provision is equivalent to existing § 1910.306(e), which requires data processing systems to have disconnecting means for electronic equipment in data processing or computer rooms and for the air conditioning system serving the area.

Several commenters noted that the 2002 edition of the NEC provided an exception to this requirement for integrated systems (Exs. 3–8, 4–11, 4–16, 4–19). Typifying these comments, the Dow Chemical Company argued as follows:

> Using disconnects for information technology systems that are part of integrated electrical systems may be an unsafe practice, since an orderly shutdown of such systems may be necessary for safety. Accordingly, OSHA should amend its proposal to include the NEC exception for integrated electrical systems. [Ex. 4–16]

OSHA agrees with these commenters that providing ready disconnecting means for integrated electrical systems can pose greater hazards for employees than having the data processing and air conditioning systems shut down as part of an orderly process. Integrated electrical systems, which are covered by final § 1910.308(g) provide for deenergizing of electric equipment in an orderly fashion to prevent hazards to people and damage to equipment. For example, in certain chemical processes, a cooling system is needed to maintain control over the chemical process. Deenergizing the cooling system for this process while the chemical reaction continues can lead to catastrophic failure of containment vessels, which lead to extensive property damage and employee injuries. Consequently, OSHA is including an exception to final § 1910.306(e) for integrated electrical systems covered by § 1910.308(g).

M. Carnivals, Circuses, Fairs, and Similar Events

Proposed § 1910.306(k) contained new requirements for carnivals,

[27] See final § 1910.305(j)(1)(iv) for fixtures, which contains a corresponding requirement for fixtures installed in wet or damp locations.

[28] The definition of ''damp location'' reads as follows:

> Partially protected locations under canopies, marquees, roofed open porches, and like locations, and interior locations subject to moderate degrees of moisture, such as some basements, some barns, and some cold-storage warehouses.

circuses, exhibitions, fairs, traveling attractions, and similar events. No comments were received concerning these provisions, and OSHA is carrying them forward into the final rule unchanged. The requirements in final § 1910.306(k), which are based on corresponding requirements in NFPA 70E, cover the installation of portable wiring and equipment for these temporary attractions. From 1991 to 2002, OSHA received reports of 46 serious accidents [29] associated with carnivals, circuses, exhibitions, fairs, and similar events (Ex. 2–7). Eleven of these accidents, resulting in 10 fatalities and 5 injuries, involved electric shock. Eight of those 11 cases (8 fatalities and 1 injury) involved electric wiring and equipment covered by the installation requirements in Subpart S. OSHA believes that the new electrical requirements for these events will prevent similar accidents in the future.

In paragraph (k) of final § 1910.306, OSHA is requiring mechanical protection of electric equipment (paragraph (k)(1)) and of wiring methods in and around rides, concessions, or other units subject to physical damage (paragraph (k)(2)). Inside tents and concession stands, the electrical wiring for temporary lighting must be secured and protected from physical damage (paragraph (k)(3)). In paragraph (k)(4), the final rule sets requirements for portable distribution and termination boxes. These new provisions will provide more electrical safety for employees working in and around this equipment.

Under final § 1910.306(k)(5), the disconnecting means must be readily accessible to the operator; that is, the fused disconnect switch or circuit breaker must be located within sight and within 1.83 meters (6 feet) of the operator for concession stands and rides. This provision provides protection by enabling the operator to stop the equipment in an emergency. The disconnecting means must also be lockable if it is exposed to unqualified persons, to prevent such persons from operating it.

N. Zone Classification

Introduction. Existing § 1910.307 contains OSHA's electrical safety requirements for locations that can be hazardous because of the presence of flammable or combustible substances. Hazardous locations are classified according to the properties of flammable vapors, liquids or gases, or combustible dusts or fibers that may be present. These locations are designated in the NEC and existing § 1910.307 as one of six types: Class I, Division 1; Class I, Division 2; Class II, Division 1; Class II, Division 2; Class III, Division 1; and Class III, Division 2. This system is called the ''division classification system,'' or the ''division system.'' The NEC first addressed this system in 1920. The OSHA website has a short but informative paper on this topic, which is available at *http://www.osha.gov/doc/outreachtraining/htmlfiles/hazloc.html.*

The 2000 edition of NFPA 70E incorporates an alternative system (in addition to the division classification system) for installing electric equipment in Class I locations. (Class II locations continue under the division system.) This system is called the ''zone classification system,'' or the ''zone system.'' The zone system designates three classifications: Class I, Zone 0; Class I, Zone 1; and Class I, Zone 2. The zone system is based on various European standards that were developed by the International Electrotechnical Commission (IEC).[30] A modified version of this system was first adopted into the NEC in the 1996 edition. Although the zone and division classification systems differ in concept, individual equipment can be approved for use under both systems when the equipment incorporates protective techniques for both systems (as determined by the nationally recognized testing laboratory that lists or labels the equipment). Based on the successful use of the zone system in European countries for many years and the acceptance of the zone system by the NEC and international standards, OSHA believes that an installation conforming to requirements for this system is as safe as one conforming to requirements for the division system.

The zone system incorporated in the final rule is an alternative method to the division system; employers may use either system for installations of electric equipment in Class I hazardous locations. OSHA will recognize the use of the zone system under § 1910.307 and any other OSHA standard that references § 1910.307.[31]

As noted earlier, OSHA is requiring employers to document the designation of hazardous locations within their facilities in final § 1910.307(b). The documentation must denote the boundaries of each division or zone so that employees who install, inspect, maintain, or operate equipment in these areas will be able to determine whether the equipment is safe for the location. As noted earlier, OSHA is requiring documentation for the division system only for new installations that use that system. The document requirement does apply, however, to all installations made under the zone system.

Several commenters supported the proposed requirement for documenting installations (Exs. 3–5, 3–9, 5–2). For example, NIOSH stated:

> An important addition to the proposed standard is the new requirement for employers to document the designation of hazardous locations within their facilities, thus allowing workers who install, inspect, maintain, or operate equipment in these areas to identify the correct equipment or system components to be used to ensure worker safety. This requirement would also ensure that the employer maintain a record of the boundaries of each hazardous location and its classification either under the current division system or the proposed zone system. [Ex. 3–9–1]

One commenter objected to the documentation requirement to the extent that it would apply to shipbuilding and ship repair (Ex. 3–7). The commenter argued as follows:

> [Proposed § 1910.307] requires documentation of each hazardous location, followed by design and installation of equipment meeting certain requirements. The standard does not appear to consider mobile operations and the difficulty in maintaining documentation for an interim operation. For instance, in shipbuilding and repair, ship modules and compartments must be spray painted. Therefore, at the time the compartment is being painted, it may meet the definition of a Class I, Division 2 area.
>
> There are over 3,000 compartments on an aircraft carrier that will be spraypainted at least twice during the course of construction. It is not feasible or realistic to expect shipyards to maintain a list of precisely which compartments are being spraypainted on any particular day. Furthermore, it provides no added protection since controls are already established as required by 29 CFR 1915, Subpart B. Subpart B—Confined and Enclosed Spaces and Other Dangerous Atmospheres, including 1915.13 (Cleaning and Other Cold Work), specifies the required

[29] These accidents were investigated by OSHA generally in response to employer reports of a fatality or three or more hospitalized injuries.

[30] The IEC prepares and publishes international standards for all electrical, electronic and related technologies. This global organization is made up of members from more than 60 participating countries, including the U.S.

[31] Several OSHA general industry standards outside Subpart S require electric equipment to meet the Subpart S requirements for Class I, Division 1 or 2 locations. For example, § 1910.103(b)(3)(ii)(*e*) requires electric equipment installed in separate buildings housing gaseous hydrogen systems to meet the Subpart S provisions for Class I, Division 2 locations. Although the Agency is not revising any of these other general industry standards to specifically accept installations meeting the Subpart S zone system requirements, OSHA will consider any nonconformance by an installation that the employer can demonstrate is properly classified and installed under the Subpart S zone system requirements as a *de minimis* violation.

controls for spraypainting and other cold work, including when explosion proof, self-contained lamps or other electric equipment must be approved and used. Based on our evaluation that current shipyard standards in Subpart B, 1915 provide equal or greater protection and the infeasibility of documenting mobile operations, we request that OSHA clarify in the applicability section or in the preamble to the final rule that Subpart B is applicable to the shipbuilding and repair industry in lieu of 1910.307. [Ex. 3–7–1]

OSHA does not agree that areas being spraypainted on a temporary basis are Class I locations. The areas described by the commenter are normally nonhazardous locations that are made hazardous through the temporary introduction of flammable gases and vapors; thus, they would not be considered a hazardous location. (See 55 FR 32008.) In most general industry applications, § 1910.334(d) applies to the temporary or occasional use of flammable materials. In the commenter's specific case, the shipyard employment standards in Subpart B of 29 CFR Part 1915 apply, as the commenter noted (Ex. 3–7–1).[32] Consequently, the employer is not required to document these locations unless the painting is done in a location that is hazardous when the spray painting operation is not being performed.

ORC Worldwide recommended that OSHA clarify what employers must include in their documentation of hazardous locations in a nonmandatory appendix. As noted earlier, final § 1910.307(b) requires documentation that denotes the boundaries of each division or zone. The documentation may be in the form of drawings that visually depict the boundaries or in text that precisely describes the extent of each hazardous location. Examples of acceptable documentation are contained in the NEC (see, for example, Figure 514.3, showing the extent of Class I, Division 1 and 2 locations surrounding motor fuel dispensers, commonly known as gasoline pumps) and in several national consensus standards included in Appendix A to Subpart S (see, for example, ANSI/API RP 505–1997, Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Zone 0, Zone 1, or Zone 2). Because these standards are already listed in Appendix A, OSHA does not believe it is necessary to include a separate appendix on the documentation requirements in final § 1910.307.

Changes to OSHA's existing requirements for the division classification system. The term ''hazardous concentrations'' is currently used in various definitions of specific hazardous locations in § 1910.399. For example, § 1910.399 defines ''Class I, Division 1,'' in part, as follows:

> A Class I, Division 1 location is a location: (a) in which hazardous concentrations of flammable gases or vapors may exist under normal operating conditions * * *

The final standard replaces the term ''hazardous concentrations'' with ''ignitable concentrations'' in each of the definitions of Class I locations in § 1910.399. This change reflects changes already incorporated into the NEC (both the 1999 and 2002 editions) and the 2000 edition of NFPA 70E to make the definitions more specific about the hazard being addressed. The changes, which OSHA does not consider to be substantive, make these definitions clearer in addition to making the OSHA standard consistent with the latest editions of NEC and NFPA 70E.

OSHA is also adding a new paragraph (f) to final § 1910.307 that lists specific protection techniques under the division system. Neither the current Subpart S nor NFPA 70E explicitly list particular protection techniques that can be used in the division classification system; however, the NEC does provide specific protection techniques for installations made under the division classification system in various requirements throughout the Articles covering hazardous locations. OSHA has listed these techniques in one paragraph in the final rule to make the standard easier to use and to provide parallel requirements for both the division classification system and the zone classification system, which is addressed in final § 1910.307(g). Protective techniques other than those listed in final paragraph (f) are acceptable if the equipment is: (1) Intrinsically safe as specified in § 1910.307(c)(1); (2) approved for the specific hazardous location as specified in § 1910.307(c)(2); or (3) of a type and design that the employer demonstrates is safe for the specific hazardous location as specified in § 1910.307(c)(3). New paragraph (f) is intended to clarify the existing OSHA requirements for hazardous locations by explicitly listing the types of protective techniques that can be used under the division classification system. (The protection techniques are required implicitly under the existing standard through the requirements for approval and listing or labeling by a nationally recognized testing laboratory and through the reference to the NEC in the note following existing § 1910.307(c)(3).)

OSHA received one comment recommending the adoption of additional protection techniques for the division system (Ex. 4–22). This commenter recommended including protection techniques listed in Section 500.7 of the 2002 NEC, including nonincendive, hermetically sealed, and combustible gas detection protection techniques.

Paragraph (f)(5) of proposed § 1910.307 (final § 1910.307(f)(10)) recognized protection techniques not specifically listed in the preceding four paragraphs as long as the technique in question met proposed § 1910.307(c). Because the techniques mentioned by the commenter meet the 2002 NEC requirements for Class I hazardous locations, those techniques would have been recognized under proposed § 1910.307(f)(5). However, to clarify the standard, OSHA has included all the protective techniques listed in Section 500.7 of the 2002 NEC in final § 1910.307(f).

Brief background and description of the zone system. The zone system stemmed from the independent efforts of countries in Europe and elsewhere to develop an area classification system to address safety in locations containing hazardous substances. The IEC formalized these efforts into the zone system, which is now used to classify the majority of the world's hazardous location systems.[33]

Article 505 of the 1996 NEC included requirements for the U.S. version of the zone system for the first time. The 2000 edition of NFPA 70E includes requirements for the zone system based on the 1999 version of the NEC. OSHA is adopting zone system rules that are based on these NFPA 70E provisions. This will permit electric equipment approved for use in hazardous locations to be used in U.S. workplaces, under either the division or zone system.

Major differences between the division classification system and the zone classification system. The zone system can best be described by comparing it with the division system. Both systems characterize locations by the likelihood and circumstances under which flammable gases or vapors exist.

[32] Other provisions that may be applicable in shipyard employment include §§ 1915.35 and 1915.36.

[33] Brenon, M., Kelly, P., McManama, K., Klausmeyer, U., Shao, W., Smith, P., ''The Impact of the IECEx Scheme on the Global Availability of Explosion Protected Apparatus,'' Record of Conference Papers of the 1999 Petroleum and Chemical Industry Technical Conference, September 13–15, 1999, Paper No. PCIC–99–07, pp. 99–109.

The systems both define the types of gases or vapors that may exist and categorize them under a number of groups. Each system specifies an allowable range of operating temperature, and corresponding requirements, for electric equipment used in a particular division or zone.

In contrast to the division system, however, the zone system is only used to classify areas that are hazardous because of the presence of flammable gases or vapors (Class I locations). The division system must be used to classify areas that may contain combustible dusts or easily ignitable fibers or flyings (Class II and III locations, respectively).

The zone system defines three types of Class I locations (Zones 0, 1, and 2) rather than two locations under the division system (Divisions 1 and 2). Zones 0 and 1 equate to Division 1, whereas Zone 2 equates to Division 2. In a Class I, Division 1 location, flammable gases or vapors are or may be present in the air in ignitable concentrations. In a Class I, Zone 1 location, ignitable concentrations of flammable gases or vapors are not always present, but such concentrations may exist periodically even under normal conditions. By contrast, in a Class I, Zone 0 location, such gases or vapors are present either continuously or for long periods. (See Table 2.) Thus, a Class I, Zone 0 location is, in essence, a worst-case Class I, Division 1 location.

Each system classifies flammable gases and vapors into a number of groups. The division system has four such groups, designated A, B, C, and D, with group A containing the most volatile substances, and groups B, C, and D containing gases or vapors that are progressively less volatile. The zone system has three such groups, designated IIA, IIB, and IIC, with group IIC containing the most volatile gases, and groups IIA and II B containing gases or vapors that are progressively less volatile. Substances classified under groups A and B in the division system generally fall under group IIC of the zone system. However, some differences exist between the groups in the two systems. Thus, regardless of the classification system being used, equipment intended for use in a Class I hazardous location must indicate the groups for which it is approved, as required by final § 1910.307(c)(2)(ii) and (g)(5)(ii). Table 2 summarizes the similarities and differences between the two systems.

The other major differences concern the allowable protection schemes and the maximum allowable surface temperature of equipment under each system. The protection schemes acceptable for each division and zone are listed in Table 3, and the remainder of this paragraph discusses the differences in maximum allowable temperature. According to the NEC, equipment is acceptable for a hazardous location only if its surface temperatures will not approach the ignition temperature, or more specifically the autoignition temperature, of the particular gases and vapors that might be present in that location. There are 14 temperature limits, and corresponding identification codes, under the division system. Each limit specifies the maximum surface temperature for equipment labeled with the matching code. There are six such temperature limits and corresponding identification codes under the zone system. The six zone system limits correspond directly to 6 of the 14 division system temperature limits. However, as shown in Table 2, the remaining eight division temperature limits have values intermediate to the six zone system temperature limits. For example, the division system has 4 intermediate temperature limits, 215 °C, 230 °C, 260 °C, and 280 °C (T2D, T2C, T2B, and T2A, respectively), between the zone system's temperature limits of 200 °C (T3) and 300 °C (T2). Equipment approved for one of these intermediate values may be used under the zone system only for the higher (in temperature) of the two closest zone system values. For example, equipment marked T2A under the division system, which has a maximum surface temperature of 280 °C, could only be used in locations where the ignition temperature of the substance is greater than or equal to the T2 value, which is 300 °C. In essence, T2A equipment becomes derated to T2 equipment when it is installed using the zone classification system. It could not be used in zone-classified locations where the ignition temperature of the substance is less than or equal to the T3 value, which is 200 °C, because the equipment could become hot enough to cause ignition.

More details on the differences in gas groups. In the 1999 NEC, the definitions for each of the division system gas and vapor groups, except Group A,[34] were changed to make them comparable to the definitions of the zone system groups. A gas or vapor is classified in the division system's Group B, C, or D or the zone systems Group IIC, IIB, or IIA based on the gas's or vapor's maximum experimental safe gap (MESG)[35] or its minimum igniting current ratio (MIC ratio).[36] These values are established under standard experimental conditions for each gas and vapor.

The 1999 NEC indicates two factors that may affect MESG and MIC values: (1) Lower ambient temperatures (lower than minus 25 °C or minus 13 °F), and (2) oxygen enriched atmospheres. The 1999 NEC Handbook states that the latter factor can drastically change the explosion characteristics of materials. Such an atmosphere lowers the minimum ignition energy, increases the explosion pressure, and can reduce the maximum experimental safe gap. These factors would make it unsafe to use otherwise approved ''intrinsically safe'' and ''explosion-proof'' equipment, unless the equipment has been tested for the specific conditions involved. Employers must ensure that the equipment approval is valid for the actual conditions present where the equipment is installed. This is required generally for all electric equipment. However, it is essential in hazardous locations because of the dire consequences that may result.

Rationale for adopting the zone system requirements. As stated earlier, the zone system has been accepted in many countries. Such international acceptance has meant that U.S. manufacturers of electric equipment suitable for installation in hazardous locations have had to ensure that their equipment met the zone system requirements if they wished to sell such equipment in zone-system countries in addition to meeting the U.S. division system requirements. Also, U.S. employers that had hazardous locations in their workplaces have sought to use equipment approved for use only in zone-classified locations in this country. This, in turn, led NFPA to incorporate the zone system in the NEC starting in the 1996 edition.

OSHA has determined that employees can be protected from the hazards of explosion in Class I hazardous locations by the installation of electric equipment following the latest NEC requirements for the zone classification system (Article 505 of the 2002 NEC). Therefore, the Agency is incorporating

[34] Acetylene is the only Group A gas under the division system.

[35] The MESG is the maximum clearance between two parallel metal surfaces that has been found, under specified test conditions, to prevent an explosion in a test chamber from being propagated to a secondary chamber containing the same gas or vapor at the same concentration.

[36] The MIC ratio is the ratio of the minimum current required from an inductive spark discharge to ignite the most easily ignitable mixture of a gas or vapor, divided by the minimum current required from an inductive spark discharge to ignite methane under the same test conditions.

the zone system in this revision of the electrical installation requirements in Subpart S. Under the final standard, employers are able to comply with either the zone classification system or the division system for Class 1 hazardous locations.

New § 1910.307(g) and related definitions. In the final rule, OSHA is adding a new paragraph (g) to final § 1910.307 that covers the zone classification system. This new paragraph addresses the following topics related to the zone classification system: scope; location and general requirements; protection techniques; special precaution; and listing and marking. A brief description of the contents of each paragraph follows.

Paragraph (g)(1) permits employers to use the zone classification system as an alternative to the division classification system. As explained in paragraph (a)(4), the requirements in final § 1910.307 that are specific to installations built under the division classification do not apply to installations built under the zone classification system. Thus, paragraph (c), electrical installations; paragraph (d), conduits; paragraph (e), equipment in Division 2 locations; and paragraph (f), protection techniques do not apply to installations built under the zone system. Paragraph (g) contains counterparts to each of these requirements.

Paragraphs (g)(2)(i) and (g)(2)(ii) describe how hazardous locations are classified under the zone system. The employer must consider each individual room, section, or area separately and must designate locations according to the specific properties of the flammable gases, liquids, or vapors that might be present. The same requirements apply to the division system. (See final § 1910.307(a).)

Paragraphs (g)(2)(iii) and (g)(2)(iv) require that conduit threads be of certain types and that connections be made wrench tight. These provisions ensure that there is no arcing across conduit connections in the event that they have to carry fault current. Paragraph (d) contains similar requirements for division system installations.

Paragraph (g)(3) of final § 1910.307 presents the protection techniques that are acceptable in zone-classified hazardous locations. Electric equipment in these locations must incorporate at least one of these protection techniques, and the equipment must be approved for the specific hazardous location. The protection techniques listed in final § 1910.307(g)(3) have been taken directly from NFPA 70E–2000.

OSHA received two comments on this proposed provision (Exs. 4–11, 4–19). These comments recommended that OSHA modify proposed paragraph (g)(3) to include Exception 4 to Section 505.20(C) of the 2002 NEC, which states: ''In Class I, Zone 2 locations, the installation of open or nonexplosion-proof or nonflame-proof enclosed motors, such as squirrel-cage induction motors without brushes, switching mechanisms, or similar arc-producing devices that are not identified for use in a Class I, Zone 2 location shall be permitted.'' They argued that the 2002 NEC does not require these types of motors to use one of the listed protection types.

OSHA disagrees with these comments. The exception to which these commenters pointed is to a requirement that equipment in Class I, Zone 2 locations be specifically listed and marked as suitable for the location. (See 2002 NEC Section 505.20(C).) Final § 1910.307(g)(3), however, is based on 1999 NEC Section 505–4, which corresponds to 2002 NEC Section 505.8. The types of motors mentioned by the commenters fall under protection technique ''n'' (known as ''type of protection''). This protection technique is defined in Section 505.2 of the 2002 NEC as ''Type of protection where electrical equipment, in normal operation, is not capable of igniting a surrounding explosive gas atmosphere and a fault capable of causing ignition is not likely to occur.'' A nonexplosion-proof motor without arc producing devices must also have a surface temperature under normal operating conditions that will be lower than the ignition temperature of the gas or vapor involved to be safe in a Class I, Zone 2 location. By definition, these are locations that are subject, albeit infrequently, to the introduction of hazardous quantities of flammable gases or vapors. If the surface temperature of the motor is too high, an explosion could result in those unusual but foreseeable situations involving hazardous accumulations of flammable gases or vapors. Thus, OSHA concludes that motors addressed by the NEC exception must still meet the criteria imposed by protection technique ''n.''

On the other hand, it appears that such motors are acceptable under the 2002 NEC even though they are not marked with any protection technique.[37] Proposed § 1910.307(g)(5) would have required all equipment installed under the zone classification system to be marked either with an acceptable class and division marking or with relevant class and zone markings. Based on the 2002 NEC requirements for installing and marking electric equipment in installations made under the zone classification system, OSHA has determined that it is unnecessary for certain types of equipment to be marked as required by final § 1910.307(g)(5). Therefore, in paragraph (g)(5)(ii)(C), the Agency has added an exception to final paragraph (g)(5) for electric equipment that the employer demonstrates will provide protection from the hazards arising from the flammability for the gas or vapor and zone of location involved and will be recognized by employees as providing such protection. Employers may point to the NEC as evidence that the equipment is safe.

Paragraph (g)(4) of final § 1910.307 sets special precautions that must be taken with respect to hazardous locations classified under the zone system. First, the classification of areas and the selection of equipment and wiring must be under the supervision of a qualified registered professional engineer. This provision is contained in NFPA 70E–2000 and in the 1999 NEC. Because the zone system has been permitted in the U.S. only since 1997,[38] employers and installers in this country have had relatively little experience with installations made using the zone classification system. The technical committees that developed NFPA 70E and the NEC have determined that, for the zone system, it is essential for competent persons to classify the hazardous locations and select equipment for those locations. OSHA agrees with the consensus determination by these committees, which are composed of members (such as NRTLs, electric equipment manufacturers, electrical contractors, and affected employee organizations) with expertise in electrical safety in hazardous locations.

Some commenters objected to the requirement that the classification of areas and selection of equipment and wiring methods be under the supervision of a qualified registered professional engineer (Exs. 3–5, 3–8, 4–16). ASSE argued that qualified electricians and safety professionals should be permitted to classify areas

[37] The marking requirement is contained in Section 505.9(C) of the 2002 NEC.

[38] As noted earlier, the zone system was first incorporated into the NEC in the 1996 edition. This edition was adopted by various governmental jurisdictions beginning in 1997. Installations made using the zone system were not permitted by these jurisdictions before then. In addition, the existing OSHA standard does not permit classifying hazardous locations under the zone system, and employers have not been certain that installations made using the zone classification systems would be acceptable to OSHA.

and select equipment and wiring methods for installations made under the zone classification system (Ex. 3–5). They further stated that not all professional engineers possess the electrical background to qualify for these tasks. Dow Chemical Company urged the Agency to permit any qualified person to classify areas and select equipment for zone-classified locations. They pointed to the action the NFPA took in adopting new Article 506 for the next edition of the NEC (the 2005 NEC). Dow stated that this new article contains § 506.6, which reads as follows:

> Classification of areas, engineering and design, selection of equipment and wiring methods, installation, and inspection shall be performed by qualified persons [Ex. 3–8].

Thus, Dow argues that NFPA has endorsed using qualified persons not just qualified registered professional engineers to make these determinations.

OSHA does not agree with the rationale put forth by ASSE and Dow. The NEC design requirements for installations made under the zone classification system are general, performance-oriented provisions that demand sound engineering judgment on the part of persons responsible for designing the installation. Paragraph (g)(4) of final § 1910.307 requires the services of a qualified registered professional engineer to ensure that the person primarily responsible for the design of the installation is particularly suited to the task. A registered professional engineer who does not have an understanding of the construction and operation of the equipment and the hazards involved in zone-classified locations would not meet the criteria spelled out in final § 1910.307(g)(4) and in the definition of ''qualified person.'' [39] The NEC requirements for installations made under the division classification system, on the other hand, are far more detailed and are more specification oriented. Because the division system has been in existence in this country for so long, because electricians and safety professionals have had decades to become familiar with it, and because (as noted earlier) many consensus standards specifically delineate the boundaries of locations classified under the division system, it is much easier for an electrician or a safety professional with a strong electrical background to properly classify a hazardous location under the division classification system. Furthermore, because the NEC division-system requirements are so detailed, it is easy for an electrician or a safety professional to select equipment appropriate for such a location. It is considerably more difficult to perform those same duties under the zone classification system. It should be noted that the 2005 edition of the NEC was not available while the rulemaking record was open. However, the new article in the 2005 NEC cited by Dow does not apply to Class I locations, which are locations made hazardous because of the presence of flammable gases or vapors, but to Class II and III locations,[40] which are locations made hazardous because of the presence of combustible dust, fibers, and flyings. Class II and III locations are not as hazardous as Class I locations and do not warrant the same degree of caution. For these reasons, OSHA is carrying § 1910.307(g)(4) into the final rule unchanged.

Paragraph (g)(4) also indicates when it is safe to have locations classified using the division system on the same premises as locations classified under the zone system and vice versa. These provisions are also taken from NFPA 70E–2000.

Several commenters pointed out an error in a metric conversion in the note to proposed § 1910.307(g)(4) (Exs. 4–13, 4–15, 4–18, 4–21). The proposed note listed −13 °F as the English unit equivalent to −20 °C. The correct English value is −4 °F. The Agency has made this correction in the final rule.

Paragraph (g)(5) of final § 1910.307 contains requirements for marking equipment that is approved for hazardous locations classified under the zone system. These provisions are comparable to the corresponding marking requirements under the division system, but reflect the need to provide information necessary for safely installing equipment in a zone-classified location. As noted earlier, paragraph (g)(5)(ii)(C) contains an exception for equipment that the employer demonstrates will provide protection from the hazards arising from the flammability of the vapors, liquids, or gasses involved and that will be recognized as such by employees.

Equivalence of systems and permitted protection techniques. Table 2 shows the general equivalence between the two classification systems. It should be noted, however, that a given area classified under one system is not permitted to overlap an area classified under the other system. For example, although Division 2 and Zone 2 are basically equivalent classifications, under the final standard a Zone 2 location is permitted to touch a Division 2 location, but the two locations are not permitted to overlap. This ensures that equipment installed and maintenance performed in these locations are appropriate for the conditions in each location.[41]

TABLE 2.—EQUIVALENCE OF HAZARDOUS (CLASSIFIED) LOCATION SYSTEMS, CLASS I LOCATIONS ONLY [1] [2]

Category	Division system	Zone system
Locations	Division 1	Zone 0, Zone 1.
	Division 2	Zone 2.
Gas Groups (see Table 3 since systems are not fully equivalent).	A, B	IIC (not fully equivalent to Groups A and B).
	C	IIB (not fully equivalent to Group C).
	D	IIA (not fully equivalent to Group D).
Temperature Codes	T1 (≤450 °C)	T1 (≤450 °C).
	T2 (≤300 °C)	T2 (≤300 °C).
	T2A, T2B, T2C, T2D (≤280, ≤260, ≤230, ≤215 °C).	T2 (effectively).[3]
	T3 (≤200 °C)	T3 (≤200 °C).
	T3A, T3B, T3C (≤180, ≤165, ≤160 °C)	T3 (effectively).[3]

[39] The definition of ''qualified person'' in final § 1910.399 reads as follows: ''One who has received training in and has demonstrated skills and knowledge in the construction and operation of the electric equipment and installations and the hazards involved.''

[40] Under the zone classification system, these locations are categorized simply as Zone 20, 21, and 22 locations, with no reference to the class of the location.

[41] Division 2 and Zone 2 are basically equivalent classifications, but there are some differences in what types of equipment are acceptable in each of those locations. See, for example, the earlier discussion on maximum allowable surface temperatures.

TABLE 2.—EQUIVALENCE OF HAZARDOUS (CLASSIFIED) LOCATION SYSTEMS, CLASS I LOCATIONS ONLY [1] [2]—Continued

Category	Division system	Zone system
	T4 (≤135 °C)	T4 (≤135 °C).
	T4A (≤120 °C)	T4 (effectively).[3]
	T5 (≤100 °C)	T5 (≤100 °C).
	T6 (≤85 °C)	T6 (≤85 °C).

Notes to Table 2:
[1] Use of the equivalence shown in the table above must be done only as permitted by § 1910.307.
[2] The zone classification system described in this preamble does not cover Class II or Class III locations.
[3] See the discussion of maximum allowable surface temperatures earlier in the preamble.

Table 3 describes which protection techniques may be used in which classified locations.

TABLE 3.—PERMITTED PROTECTION TECHNIQUES (DESIGN CRITERIA) IN CLASS I LOCATIONS

	Zone 0: —intrinsically safe "ia". —Class I, Division 1 intrinsically safe.
Division 1: —explosion-proof. —purged and pressurized (Type X or Y). —intrinsically safe.	**Zone 1:** —flameproof "d". —purged and pressurized. —intrinsically safe "ib". —oil immersion "o". —increased safety "e". —encapsulation "m". —powder filling "q". —any Class I, Division 1 method. —any Class I, Zone 0 method.
Division 2: —purged and pressurized (Type Z). —intrinsically safe. —nonincendive. —oil immersion. —hermetically sealed. —any Class I, Zone 0 or 1 method. —any Class I, Zone 0, Zone 1, or Zone 2 method.	**Zone 2:** —non-sparking "nA". —protected sparking "nC". —restricted breathing "nR". —any Class I, Division 1 or 2 method. —any Class I, Zone 0 or 1 method.

Listing and labeling by NRTLs. Paragraph (a) of final § 1910.303 continues the existing requirement that all electric equipment be approved. While OSHA believes that approval is necessary for all electric equipment, the need for third-party approval of electric equipment in hazardous locations is particularly crucial. The techniques for ensuring safety in hazardous locations require careful manufacturing and testing of products because tolerances are tight and the margin for error is slim. Thus, OSHA's general industry electrical installation standard has always called for equipment approval, which generally requires listing or labeling by a nationally recognized testing laboratory (NRTL) of equipment installed in hazardous locations.[42] Under 29 CFR 1910.7, OSHA recognizes testing organizations that are capable of performing third-party testing for safety and designates them as NRTLs. Employers may use products listed by NRTLs to meet OSHA standards that require testing and certification. NRTLs test and certify equipment to demonstrate conformance to appropriate test standards. Many of these test standards cover equipment used in hazardous locations.

OSHA's existing requirements for hazardous locations in Subpart S only address locations classified under the division system, and NRTLs perform testing based on that system. However, test standards currently used by NRTLs to test equipment in hazardous locations classified by division are not automatically appropriate for testing such equipment for use under the zone system. These current test standards are based on protective techniques used for equipment designed for use under the division system and do not contain

[42] Equipment that is of a type that no nationally recognized testing laboratory accepts as being safe can achieve approval through acceptance by a Federal, State, or local authority having jurisdiction over the safety of electrical installations. Custom-made equipment can gain approval through testing by the equipment manufacturer. However, these two modes of approval are rare for equipment installed in hazardous locations. Federal, State, and local authorities generally look to NRTLs for equipment approval, and this is even more true for equipment installed in hazardous locations. This type of equipment must be tested to ensure that it is safe, and these authorities generally do not have the capability to do electrical testing. Custom-made equipment, by its nature, is very rare.

Existing § 1910.307(b) also recognizes equipment that is "safe for the hazardous (classified) location." This provision permits equipment that is approved for installation in nonhazardous locations if the employer demonstrates that the equipment will provide protection from the hazards arising from the combustibility and flammability of vapors, liquids, gases, dusts, or fibers. This condition exists only in limited circumstances as demonstrated by the 2002 NEC, which permits only certain types of general-purpose equipment in hazardous locations and then only under limited conditions. For example, Section 501.8(B) of the 2002 NEC permits nonexplosionproof enclosed motors in Class I, Division 2 locations if they have no brushes, switching mechanisms, or similar arc-producing devices and if exposed motor surfaces do not exceed 80 percent of the ignition temperature of the gas or vapor involved.

criteria for protective techniques used in the zone system. Electric equipment that has been approved by an NRTL for use in division-classified hazardous locations may be capable of igniting flammable gases or vapors when used inappropriately in zone-classified locations. Such hazardous equipment can cause a catastrophic explosion and the deaths of and injuries to many employees. In recognizing laboratories under § 1910.7 to test products designed for installation in zone-classified locations, OSHA will ensure that the proper test standards are used and look closely at the capability of the laboratory to perform testing under those standards.

Effects and changes to other Part 1910 standards (§§ 1910.103, 1910.106, 1910.107, 1910.110, 1910.178, and 1910.253). A number of other OSHA standards under 29 CFR Part 1910 contain references to or requirements related to § 1910.307. Some of these standards refer only to hazardous locations classified under the division system. The standards particularly affected are as follows:

§ 1910.103(b)(3)(ii)(*e*) and (b)(3)(iii)(*e*), (c)(1)(ix)(*a*), and (c)(1)(ix)(*b*);

§ 1910.106(d)(4)(iii), (e)(7)(i)(*b*), (e)(7)(i)(*c*), (e)(7)(i)(*d*), (g)(1)(i)(*g*), (g)(4)(iii)(*a*), (h)(7)(iii)(*b*), and (h)(7)(iii)(*c*);

§ 1910.107(c)(6), (c)(8), (j)(4)(iv);

§ 1910.110(b)(17)(v);

§ 1910.178(c)(2)(iv) and (q)(2); and

§ 1910.253(f)(4)(iv)(B) and (f)(6)(v).

OSHA is not modifying any of these standards in this rulemaking. Several of these requirements call for designating particular locations as Class I, Division 1 or Division 2 locations, and OSHA believes that revising them would not be straightforward and would be too complicated to do in this rulemaking. For example, § 1910.103(c)(1)(ix)(*a*) requires electric wiring and equipment ''located within 3 feet of a point where connections are regularly made and disconnected, shall be in accordance with Subpart S of this Part, for Class I, Group B, Division 1 locations.'' Under the zone system, this location would likely be partly a Zone 0 location and partly a Zone 1 location. Thus, this requirement cannot be revised by a straightforward substitution of ''Zone'' for ''Division.'' Similar problems exist in revising the other requirements. OSHA will make a case-by-case determination of whether a particular installation under the zone classification system meets the criteria for a *de minimis* violation based on: (1) Evidence the employer provides to show that the installation is as safe as it would be if it complied with Subpart S requirements for installations made under the division system and (2) the extent to which the employer's designation of Class I, Zone 0, 1, and 2 locations is consistent with sound engineering practices, as evidenced by national consensus and industry standards.

O. Remote Control, Signaling, Power-Limited, and Fire Alarm Circuits

Proposed § 1910.308(c) addressed Class 1, 2, and 3 remote control, signaling, and power-limited circuits. The American Petroleum Institute (API) and Dow Chemical Company noted that Section 725.55 of the 2002 NEC specifically permits many types of installations that are not listed in OSHA's proposal (Exs. 3–8, 4–11). They recommended that the OSHA standard also list permitted uses for these types of circuits for consistency with the NEC.

The provision in the 2002 NEC to which API and Dow referred (Section 725.55) does not actually list permitted uses. Rather, this provision contains requirements for separating different classes of circuits, with the method of separation differing in some respect for the various types of installations.[43] For example, Section 725.55(B) states, ''Class 2 and Class 3 circuits shall be permitted to be installed together with Class 1, non-power-limited fire alarm and medium power network-powered broadband communications circuits *where they are separated by a barrier* [emphasis added].''

Proposed § 1910.308(c), which was nearly identical to Section 6.3.1.3.1.1 of NFPA 70E–2000, read as follows:

> Cables and conductors of Class 2 and Class 3 circuits may not be placed in any cable, cable tray, compartment, enclosure, manhole, outlet box, device box, raceway, or similar fitting with conductors of electric light, power, Class 1, nonpowerlimited fire alarm circuits, and medium power network-powered broadband communications cables.

This provision in the proposal and the corresponding one in NFPA 70E were taken from 1999 NEC Section 725–54(a)(1), which contains the same basic requirement, but which also contains six exceptions to this general rule. All the exceptions permit cables and conductors of Class 2 and Class 3 circuits to be placed in one of the listed enclosures with a higher powered circuit as long as an extra barrier of one form or another is installed to separate the two different classes of circuits. Consequently, OSHA agrees with the commenters that the proposal could have unnecessarily restricted the installation of Class 2 and Class 3 circuits. On the other hand, adopting the specific language in the NEC (either the 1999 edition or the 2002 edition, which converted the exception into separate rules) would make the OSHA standard too detailed and specification oriented. To address API's and Dow's concerns, OSHA has decided to incorporate the exceptions in 1999 NEC Section 725–54(a)(1) in performance terms. Final § 1910.308(c)(3) thus reads as follows:

> Cables and conductors of Class 2 and Class 3 circuits may not be placed in any cable, cable tray, compartment, enclosure, manhole, outlet box, device box, raceway, or similar fitting with conductors of electric light, power, Class 1, nonpower-limited fire alarm circuits, and medium power network-powered broadband communications cables *unless a barrier or other equivalent form of protection against contact is employed.* [Emphasis added.]

Employers can look to the NEC to help determine acceptable methods of separating Class 2 and Class 3 circuits from electric light, power, Class 1, and nonpower-limited fire alarm circuit conductors and from medium power network-powered broadband communications cables.

OSHA received a similar comment on proposed § 1910.308(d)(3) recommending that the provision mention all the permitted uses for fire alarm circuits listed in 2002 NEC Section 760.55 (Ex. 4–22). The Agency has rejected this recommendation for the same reasons it rejected the recommendation concerning remote control, signaling, and power-limited circuits.

Dow Chemical Company objected to proposed § 1910.308(d)(3)(iii) (Exs. 3–8, 4–16). They stated their objections as follows:

> The current provision, section 1910.308(d)(4), has a 2-inch requirement for separation of power-limited conductor locations with an option for alternative protections (emphasis added):
>
> Power-limited conductor location. Where open conductors are installed, power-limited fire protective signaling circuits shall be separated at least 2 inches from conductors of any light, power, Class 1, and non-power-limited fire protective signaling circuits *unless a special and equally protective method of conductor separation is employed.*
>
> The proposed revision of that 2-inch requirement does not have that option:
>
> Power-limited fire alarm circuit conductors shall be separated at least 50.8 mm (2 in.) from conductors of any electric light, power, Class 1, nonpower-limited fire alarm, or medium power network-powered broadband communications circuits.

[43] The title of § 725.55 of the 2002 NEC is ''Separation from Electric Light, Power, Class 1, Non-Power-Limited Fire Alarm Circuit Conductors, and Medium Power Network-Powered Broadband Communications Cables.''

The preamble characterizes this change as a clarification of existing requirements (69 FR at 17792). This is not a clarification, however, but a limitation.

As a significant change, at a minimum this provision should be applicable only to installations after the effective date of the final rule under § 1910.302(b)(4). The proposed rule lists all of § 1910.308(d) as being triggered in installations made after April 16, 1981, per proposed § 1910.302(b)(3).

Further, this deletion of the option for using equally protective methods is not justified and should not be adopted. NEC § 800.52(A)(2) provides that option today with two exceptions. That provision reads:

> Other Applications. Communications wires and cables shall be separated at least 50 mm (2 in.) from conductors of any electric light, power, Class 1, non-power-limited fire alarm, or medium power network-powered broadband communications circuits.
>
> Exception No. 1: Where either (1) all of the conductors of the electric light, power, Class 1, non-power-limited fire alarm, and medium power network-powered broadband communications circuits are in a raceway or in metal-sheathed, metal-clad, nonmetallic-sheathed, Type AC, or Type UF cables, or (2) all of the conductors of communications circuits are encased in raceway.
>
> Exception No. 2. Where the communications wires and cables are permanently separated from the conductors of electric light, power, Class 1, non-power-limited fire alarm, and medium power network-powered broadband communications circuits by a continuous and firmly fixed nonconductor, such as porcelain tubes or flexible tubing, in addition to the insulation on the wire. [Ex. 3–8]

Dow further noted that NFPA provides similar exceptions to the corresponding provision in that standard. They concluded their comments as follows:

> The availability of such options is important because computer rooms, control rooms, and communications closets may have mixed wiring under the floor that relies on the availability of those exceptions.
>
> OSHA should not take away the options present in the existing rule, particularly since they are supported by both the NEC and NFPA 70E. [Ex. 3–8]

OSHA agrees with Dow's rationale. The 2002 NEC and the 2000 and 2004 editions of NFPA 70E recognize that it is safe to install power-limited fire protective signaling circuits within 50.8 millimeters (2 inches) of power conductors when there is an additional barrier between the two sets of conductors. Consequently, the Agency is adding the phrase ''unless a special and equally protective method of conductor separation is employed,'' from existing § 1910.308(d)(4) as highlighted in Dow's comments, to final § 1910.308(d)(3)(iii) to permit additional means of protecting fire protective signaling circuit conductors from contact with conductors of other circuits. The final rule, with the revision emphasized, reads as follows:

> Power-limited fire alarm circuit conductors shall be separated at least 50.8 mm (2 in.) from conductors of any electric light, power, Class 1, nonpower-limited fire alarm, or medium power network-powered broadband communications circuits *unless a special and equally protective method of conductor separation is employed.*

P. Definitions

The definitions for Subpart S are located in § 1910.399. The changes to these definitions from the existing standard reflect the provisions of the 2002 NEC and NFPA 70E–2000. Table 4 (located at the end of section I. P. of the preamble) summarizes the changes to the definitions.

OSHA is removing several definitions from the standard. ''Special permission,'' ''permanently installed swimming pools, wading and therapeutic pools,'' and ''storable swimming and wading pools'' are removed because these terms are not used in final Subpart S. Lastly, the definitions of ''electric sign'' and ''may'' are removed. The existing Subpart S definitions of these terms are not substantially different from the commonly accepted dictionary definitions. The definition of ''electric sign'' may appear different from the dictionary definition; however, the information in the existing definition adds nothing substantive within the context of the standard. Thus, their removal does not change the meaning of the standard.

The final rule redefines the term ''identified.'' The existing definition of ''identified'' applies to the use of this term in reference to a conductor or its terminal. The final rule discontinues the current standard's use of the word ''identified'' in this manner. The final rule does, however, define ''identified'' to refer to equipment suitable for a specific purpose, function, use, environment, or application.

OSHA is also removing the definition of ''utilization systems.[44]'' This term is only used in existing § 1910.301(a), which describes the content of §§ 1910.302 through 1910.308, and in the title and introductory text of existing § 1910.302. Existing § 1910.301(a) reads as follows:

> *Design safety standards for electrical systems.* These regulations are contained in §§ 1910.302 through 1910.330. Sections 1910.302 through 1910.308 contain design safety standards for electric utilization systems. Included in this category are all electric equipment and installations used to provide electric power and light for employee workplaces. Sections 1910.309 through 1910.330 are reserved for possible future design safety standards for other electrical systems.

The introductory text of § 1910.302 reads as follows:

> Sections 1910.302 through 1910.308 contain design safety standards for electric utilization systems.

These two provisions are intended as introductory text providing a general discussion of the contents of the standard. The precise scope of §§ 1910.302 through 1910.308 is presented in final § 1910.302(a). However, OSHA is concerned that some employers and employees could incorrectly interpret the use of the term ''utilization systems'' and its definition as narrowing the scope of §§ 1910.303 through 1910.308. The term ''utilization system'' in the introduction to Subpart S is intended as a shorthand way of referring to the systems covered by Subpart S generally and §§ 1910.303 through 1910.308 specifically. Removing the definition from the standard should clarify that the language used in the introduction to Subpart S is not intended to alter the scope of §§ 1910.302 through 1910.308, as given in § 1910.302(a).

OSHA is adding 13 definitions to § 1910.399. (See Table 4.) These definitions, all but one of which are based on NFPA 70E–2000 and the 2002 NEC, will help clarify the requirements in Subpart S. Other modifications made to the definitions are grammatical in nature, and no substantive change is being made in the meaning of the terms.

A few terms warrant additional explanation: ''Identified,'' ''labeled,'' and ''listed.'' The existing standard requires certain electric equipment to be ''approved for the purpose,'' and current § 1910.399 defines this term as follows:

> Approved for a specific purpose, environment, or application described in a particular standard requirement.
>
> Suitability of equipment or materials for a specific purpose, environment or application may be determined by a nationally recognized testing laboratory, inspection agency or other organization concerned with product evaluation as part of its listing and labeling program. (See ''Labeled'' or ''Listed.'')

[44] In the proposed rule, OSHA listed the removal of this definition in the preamble in a table listing the summary of changes to the definitions. However, OSHA neglected to include the removal of this definition in the proposed regulatory text.

In the final rule, OSHA is replacing the word ''approved'' in the phrase ''approved for the purpose,'' with ''identified.'' The final rule's definition of ''identified,'' which is based on the definition of this term in NFPA 70E–2000,[45] reads as follows:

Identified (as applied to equipment). Approved as suitable for the specific purpose, function, use, environment, application, and so forth, where described in a particular requirement.

Note to the definition of ''identified:'' Some examples of ways to determine suitability of equipment for a specific purpose, environment, or application include investigations by a nationally recognized testing laboratory (through listing and labeling), inspection agency, or other organization recognized under the definition of ''acceptable.''

The definition of ''identified'' as it applies to equipment is intended to be equivalent to the existing definition of ''approved for the purpose.'' [46]

In the final rule, OSHA uses the terms ''listed'' and ''labeled'' to refer to electric equipment determined to be safe by a nationally recognized testing laboratory (NRTL). When equipment has been listed and labeled, this means that the equipment has been tested and found safe for use by a nationally recognized testing laboratory. The laboratory marks the equipment with a symbol identifying its trademark. The equipment is then considered by OSHA to be safe for its intended use. If the equipment is altered or used for other purposes, then the equipment is not acceptable under Subpart S. The laboratories typically require the equipment to be marked with such information as: The standards under which the equipment has been tested; the current rating in amperes; and the frequency. OSHA evaluates and recognizes ''nationally recognized testing laboratories'' under § 1910.7 to test equipment for safety and label or list it. It should be noted that the final rule would continue the existing § 1910.399 definitions of ''labeled'' and ''listed'' without substantive change.

The Dow Chemical Company recommended that OSHA supplement the proposed definition of ''identified'' with language from Section 500.8(A)(1) of the 2002 NEC so that the definition would read as follows:

Suitability of identified equipment for the purpose shall be determined by any of the following:

(1) Equipment listing or labeling;

(2) Evidence of equipment evaluation from a qualified testing laboratory or inspection agency concerned with product evaluation; or

(3) Evidence acceptable to the authority having jurisdiction, such as a manufacturer's self-evaluation or an owner's engineering judgment. [Ex. 3–8]

Dow Chemical believes that this language would provide flexibility to the employer when the equipment is not approved by a nationally recognized testing laboratory.

As noted earlier, § 1910.303(a) requires electric equipment to be approved, and the definitions of ''approved'' and ''acceptable'' set out what types of equipment OSHA will accept in enforcing Subpart S.[47] Dow's suggestion does not clarify these definitions. Instead, it seems to imply equivalence between the three listed options. In comparison, OSHA's existing definition of ''acceptable'' clearly indicates a preference for listing, labeling, or other approval by a nationally recognized testing laboratory. At the same time, OSHA's existing definitions provide flexibility for employers when equipment is of a type that no nationally recognized testing laboratory evaluates. OSHA believes that the proposed definitions of ''identified,'' ''approved,'' and ''acceptable'' are clear and provide sufficient flexibility to employers. Therefore, the Agency is carrying them forward into the final rule without change.

The proposed definition of ''acceptable'' reads as follows:

An installation or equipment is acceptable to the Assistant Secretary of Labor, and approved within the meaning of this Subpart S:

(1) If it is accepted, or certified, or listed, or labeled, or otherwise determined to be safe by a nationally recognized testing laboratory recognized pursuant to § 1910.7; or

(2) With respect to an installation or equipment of a kind that no nationally recognized testing laboratory accepts, certifies, lists, labels, or determines to be safe, if it is inspected or tested by another Federal agency, or by a State, municipal, or other local authority responsible for enforcing occupational safety provisions of the National Electrical Code, and found in compliance with the provisions of the National Electrical Code as applied in this subpart; or

(3) With respect to custom-made equipment or related installations that are designed, fabricated for, and intended for use by a particular customer, if it is determined to be safe for its intended use by its manufacturer on the basis of test data which the employer keeps and makes available for inspection to the Assistant Secretary and his authorized representatives.

Mr. Ron Nickson, representing the National Multi Housing Council and the National Apartment Association, recommended that OSHA add the International Code Council Electrical Code (ICCEC), which is published by the International Code Council (ICC), to the second alternative in the definition of ''acceptable'' (Ex. 4–20). They believe that OSHA should accept evaluations made by local authorities enforcing the ICCEC as being equivalent to those made by authorities enforcing the NEC. In support of their position, they stated:

The provisions in the ICCEC were developed during the ICC code development process to address and/or expand on issues not covered in the NEC. The ICC codes, including the ICCEC, are the result of more than 90 years of code enforcement by local building and fire officials. The ICCEC responds to issues that have come up during the inspection and approval process or have been brought to the attention of the ICC by participants in the ICC code development process. They have been reviewed by ICC Code development committees and voted into the code by the building and fire official members of ICC. They form an important part of the electrical installation and inspection process to insure that electrical work is installed in a safe manner to limit the possibility of injury to workers and others involved in the construction process. [Ex. 4–20]

The commenter acknowledged that there are differences between the NEC and the ICCEC. However, there is little information in Mr. Nickson's submission or elsewhere in the rulemaking record that would enable OSHA to judge whether an evaluation of an electrical installation made under the ICCEC would be equivalent to one made under the NEC. In addition, Mr. Nickson does not present any evidence of how many jurisdictions, if any at all, enforce the ICCEC. Consequently, the Agency has decided against adding the International Code Council Electrical Code to the definition of ''acceptable.''

[45] Except for the note to the definition, the exact language was taken from the 2002 NEC. This version is clearer than the definition in NFPA 70E, but the intent is the same. OSHA has clarified the note to indicate that acceptability of testing and inspection agencies is given in the definition of ''acceptable.''

[46] NFPA 70E–2000 uses the word ''recognizable'' in lieu of ''approved'' in the definition of ''identified.'' It also contains a fine print note following the definition indicating that suitability of equipment for a specific purpose, environment, or application may be determined by a qualified testing laboratory, inspection agency, or other organization concerned with product evaluation. The revised and existing OSHA standards both require all electric equipment to be approved, and this approval is the only mechanism for recognizing equipment as suitable. The Agency believes that the proposed definition of ''identified'' as applied to equipment clarifies the intent of the standard and is consistent with the existing standard's provisions that require electric equipment to be ''approved for the purpose.''

[47] OSHA proposed no substantive changes to the definitions of ''approved'' or ''acceptable'' or to the requirement in existing § 1910.303(a) that electric equipment be approved.

However, if in enforcing Subpart S the Agency determines that the underlying electrical standard, such as the ICCEC, being used by a particular local authority is based on the NEC, then OSHA will consider accepting that authority's determinations of electrical installation safety under the second alternative given in the definition of ''acceptable.''

OSHA received several comments suggesting the addition of a definition of ''fountain'' to clarify the use of this word in proposed § 1910.306(j)(5) (Exs. 4–13, 4–15, 4–18, 4–21). Typifying these comments, Mr. Michael Kovacic argued that the term ''fountains'' has been the source of considerable confusion and misinterpretation for many years. He stated that, although some apply the requirements on fountains in existing § 1910.306(j)(5) to drinking fountains and water coolers, the NEC does not intend to apply the requirements on fountains to drinking fountains. To support his assertion, he pointed to 2002 NEC Section 680.2, which states that the definition of ''fountains'' does not include drinking fountains. The commenters recommend that OSHA either add the NEC definition of ''fountains'' to § 1910.399 or otherwise clarify the application of § 1910.306(j)(5).

OSHA agrees with these commenters and has included the 2002 NEC definition of ''fountains'' in final § 1910.399.

The Agency has also retained the proposed definitions of ''permanently installed swimming pools, wading and therapeutic pools'' and ''storable swimming or wading pool.'' The preamble indicated that the definitions of these terms were to be removed because the terms were not used in the proposed standard. However, the proposal did include definitions of these terms in the regulatory text. The introductory text to final § 1910.306(j) reads, in part, as follows:

> This paragraph applies to electric wiring for and equipment in or adjacent to all swimming, wading, therapeutic, and decorative pools and fountains; hydro-massage bathtubs, *whether permanently installed or storable;* and metallic auxiliary equipment, such as pumps, filters, and similar equipment. [Emphasis added.]

OSHA believes that defining the terms ''permanently installed swimming pools, wading and therapeutic pools'' and ''storable swimming or wading pool'' will clarify the intent of final § 1910.306(j). Even though the terms are not used precisely in the form used in the definitions, it is clear from the regulatory text that those two terms are what OSHA intends by the language in final § 1910.306(j).

Proposed § 1910.308(c)(1) contained requirements governing the marking and limitations on power of Class 1, 2, and 3 remote control, signaling, and power-limited circuits. Some commenters recommended clarifying the standard by moving those provisions to § 1910.399 or by including a cross-reference to § 1910.308(c)(1) within the definition section.

Paragraph (c)(1) of final § 1910.308 sets mandatory limits on the power output for remote control, signaling, and power-limited circuits and sets requirements for marking the source of power for these circuits. These provisions are requirements, not definitions. Consequently, the Agency does not believe that it is appropriate to move them to or refer to them in the definition section.

Some commenters identified definitions in the proposed rule that were inconsistent with the definitions in the NFPA 70E–2004 (Exs. 4–11, 4–19). They identified as examples: ''Armored cable'' and ''live parts.'' [48] The commenters recommended that the definitions in § 1910.399 be consistent with NFPA 70E and the NEC.

In comparing the proposed definition of ''live parts'' with the one in the 2002 NEC (on which NFPA 70E–2004 is based), OSHA has found that the definition in its proposal is only slightly different from that of NFPA.[49] The intent of OSHA's definition and the NEC definition is identical. To promote consistency with the NEC and NFPA 70E, the Agency has decided to adopt the 2002 NEC language for this definition in the final OSHA rule.

The definition of ''armored (Type AC) cable'' in the proposal is identical to the one in the 2002 NEC, though OSHA's proposed definition is worded as a complete sentence. The Agency has reworded the definition in the final rule (along with similarly worded definitions [50]) so that the format matches the other definitions in the final rule and the NEC.

In addition, the Agency has identified two additional definitions that could be clarified with the use of the corresponding 2002 NEC definitions: ''Health care facilities'' and ''mineral-insulated, metal sheathed cable.''

The existing and proposed definitions of ''health care facilities'' read as follows:

> Buildings or portions of buildings and mobile homes that contain, but are not limited to, hospitals, nursing homes, extended care facilities, clinics, and medical and dental offices, whether fixed or mobile.

This is not a true definition. Rather, it provides examples of health care facilities. The 2002 NEC definition of this term, in § 517.2, reads as follows:

> Buildings or portions of buildings in which medical, dental, psychiatric, nursing, obstetrical, or surgical care are provided. Health care facilities include, but are not limited to, hospitals, nursing homes, limited care facilities, clinics, medical and dental offices, and ambulatory care centers, whether permanent or moveable.

OSHA believes that this language will clarify how that term is used and has adopted the NEC definition in the final rule.

The proposed definition of ''mineral-insulated, metal sheathed cable'' stated that this was a type of cable with a ''continuous copper sheath.'' The 2002 NEC states that the sheath may be of alloy steel in addition to copper. For consistency with the 2002 NEC, OSHA has revised the term ''continuous copper sheath'' from the definition in the proposal to ''continuous copper or alloy steel sheath'' in the final rule. This will ensure that the OSHA standard recognizes all the different types of approved mineral-insulated, metal sheathed cables currently available.

The proposed definition of ''qualified person'' read as follows:

> A person who is familiar with the construction and operation of the equipment and the hazards involved. [Notes omitted.]

OSHA received several comments on this definition (Exs. 4–11, 4–13, 4–15, 4–18, 4–19, 4–21). These commenters recommended that OSHA use the corresponding definition from the 2002 NEC, which reads:

> One who has the skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training on the hazards involved.

Some of these commenters asserted that there is confusion in the electrical safety industry over the use of this term (Exs. 4–13, 4–15, 4–18, 4–21). They also recommended including a note

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[48] These commenters also identified the definition of ''qualified person'' as being inconsistent with the NEC definition. This comment is addressed later in this section of the preamble.

[49] The NEC definition of ''live parts'' is ''energized conductive componenets.'' OSHA's proposed definition was ''[E]lectric conductors, buses, terminals, or components that are energized.'' Since the word ''components'' includes conductors, buses, and terminals, there is no substantive difference between the two definitions.

[50] The following definitions were similarly worded in the proposed rule: ''Medium voltage cable,'' ''metal-clad cable,'' ''mineral-insulated metal-sheathed cable,'' ''nonmetallic-sheathed cable,'' ''power and control tray cable,'' ''power-limited tray cable,'' ''service-entrance cable,'' ''shielded nonmetallic-sheathed cable,'' and ''wireways.''

regarding the type of training needed before an employee could meet the definition.

Paragraph (b)(3) of existing § 1910.332 set specific training requirements that an employee must have to be considered a ''qualified person.'' In fact, the first note to the proposed definition of ''qualified person'' pointed to that training requirement. Although the suggested definition is consistent with the training provisions, it does not demand that the person have the knowledge and skills related to the hazards posed by electrical installations that are to be imparted by the training. To capture the commenters' intent and retain the proposed definition's emphasis on acquired knowledge, the Agency is adopting the following definition of ''qualified person:''

> One who has received training in and has demonstrated skills and knowledge in the construction and operation of electric equipment and installations and the hazards involved.

The final rule also carries forward, unchanged, the two notes to the proposed definition.

TABLE 4.—SUMMARY OF CHANGES TO THE DEFINITIONS

Old definition	New definition	Rationale
	Barrier	OSHA is adding this definition to § 1910.399 from NFPA 70E–2000.
	Bathroom	OSHA is adding this definition to § 1910.399 from NFPA 70E–2000.
	Class I, Zone 0	OSHA is adding this definition to § 1910.399 from NFPA 70E–2000 to support the new section on Zone Classification in § 1910.307.
	Class I, Zone 1	OSHA is adding this definition to § 1910.399 from NFPA 70E–2000 to support the new section on Zone Classification in § 1910.307.
	Class I, Zone 2	OSHA is adding this definition to § 1910.399 from NFPA 70E–2000 to support the new section on Zone Classification in § 1910.307.
	Competent person	OSHA is adding this definition to § 1910.399 from § 1926.32. See discussion earlier in the preamble.
Electric sign	[Removed]	No substantive change. See the detailed explanation earlier in this section of the preamble.
	Energized	OSHA is adding this definition to § 1910.399 from NFPA 70E–2000.
	Fountain	OSHA is adding this definition to § 1910.399 from NEC–2002. See the detailed explanation earlier in this section of the preamble.
Health care facilities	Health care facilities	OSHA is removing the old definition and adding the new definition to § 1910.399 from NEC–2002. See the detailed explanation earlier in this section of the preamble.
Identified	Identified	This term is used in a different manner in the proposed revision. The new use and definition are taken from NFPA 70E–2000. See the detailed explanation earlier in this section of the preamble.
	Insulated	OSHA is adding this definition to § 1910.399 from NFPA 70E–2000.
	Live parts	OSHA is adding this definition to § 1910.399 from NEC–2002.
May	[Removed]	No substantive change. The definition adds nothing to the dictionary definition of this term.
	Motor Control Center	OSHA is adding this definition to § 1910.399 from NFPA 70E–2000.
Nonmetallic-sheathed cable	Nonmetallic-sheathed cable	OSHA is removing the old definition and adding the new definition to § 1910.399 from NEC–2002. See the detailed explanation earlier in this section of the preamble.
	Overhaul	OSHA is using this term in the standard in place of ''major replacement, modification, repair, or rehabilitation,'' which is used in the existing standard to delineate when an electrical installation must meet new requirements in the standard. See the explanation of the definition and related changes under the summary and explanation of the grandfather clause earlier in this preamble.
Qualified person	Qualified person	OSHA is revising this definition. (See the summary and explanation of the definition of ''qualified person,'' earlier in this section of the preamble.)
	Service point	OSHA is adding this definition to § 1910.399 from NFPA 70E–2000.
Special permission	[Removed]	This term is not used in Subpart S.
Utilization system	[Removed]	This definition is being removed. See the detailed explanation earlier in this section of the preamble.

Q. Appendices

Appendices B and C of the current Subpart S contain no material; they are reserved for future use. OSHA is removing these two ''empty'' appendices because the Agency has no material to include there.

The existing Appendix A contains a list of references. OSHA is revising and updating the references in this appendix to reflect the most recent editions of various national consensus standards.[51] These nonmandatory references can be used to assist employers who desire additional information that will help them to comply with the performance standard in Subpart S. In addition, OSHA is removing various reference standards from the appendix because the documents are no longer in print and because the information can be found in other listed sources. The following references are removed:

ANSI B9.1–71 Safety Code for Mechanical Refrigeration;

ANSI B30.15–73 Safety Code for Mobile Hydraulic Cranes;

[51] The references in Appendix A in the final rule are to the latest revisions of the relevant documents, except for references to the NEC and NFPA 70E. For these two NFPA standards, OSHA has listed both the current versions (NFPA 70–2005 and 70E–2004) and the versions on which the final rule is based (NFPA 70–2002 and 70E–2000). The Agency has reviewed these documents and found them to provide suitable guidance to assist employers in complying with the OSHA standards.

ANSI C33.27–74 Safety Standard for Outlet Boxes Fittings for Use in Hazardous Locations, Class I, Groups A, B, C, and D, and Class II, Groups E, F, and G;
ASTM D2155–66 Test Method for Autoignition Temperature of Liquid Petroleum Products;
IEEE 463–77 Standard for Electrical Safety Practices in Electrolytic Cell Line Working Zones;
NFPA 56A–73 Standard for the Use of Inhalation Anesthetics (Flammable, Nonflammable);
NFPA 56F–74 Standard for Nonflammable Medical Gas Systems;
NFPA 70C–74 Hazardous Locations Classification;
NFPA 71–77 Standard for the Installation, Maintenance, and Use of Central Station Signaling Systems;
NFPA 72A–75 Standard for the Installation, Maintenance, and Use of Local Protective Signaling Systems for Watchman, Fire Alarm, and Supervisory Service;
NFPA 72B–75 Standard for the Installation, Maintenance, and Use of Auxiliary Protective Signaling Systems for Fire Alarms Service;
NFPA 72C–75 Standards for Installation, Maintenance, and Use of Remote Station Protective Signaling Systems;
NFPA 72D–75 Standard for the Installation, Maintenance and Use of Proprietary Protective Signaling Systems for Watchman, Fire Alarm, and Supervisory Service;
NFPA 72E–74 Standard for Automatic Fire Detectors;
NFPA 74–75 Standard for Installation, Maintenance, and Use of Household Fire Warning Equipment;
NFPA 76A–73 Standard for Essential Electrical Systems for Health Care Facilities;
NFPA 86A–73 Standard for Ovens and Furnaces; Design, Location and Equipment;
NFPA 88B–73 Standard for Repair Garages;
NFPA 325M–69 Fire-Hazard Properties of Flammable Liquids, Gases, and Volatile Solids; and
NFPA 493–75 Standard for Intrinsically Safe Apparatus for Use in Class I Hazardous Locations and Its Associated Apparatus.

OSHA is adding five national consensus standards to the list.[52] All but one of these documents refers to hazardous (classified) locations. The other document addresses articulating boom cranes. ANSI/ASME B30.22–2005 Articulating Boom Cranes was not included in the proposal. However, the Agency has reviewed this standard and has found useful information comparable to the other ANSI/ASME standards for other types of cranes (for example, ANSI/ASME B30.5–2004 Mobile And Locomotive Cranes). Consequently, the following references are added:

ANSI/UL 913–2002 Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations;
ANSI/API RP 500–1998 (2002) Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I Division 1 and Division 2;
ANSI/API RP 505–1997 (2002) Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Zone 0, Zone 1 and Zone 2;
ANSI/ASME B30.22–2005 Articulating Boom Cranes; and
NFPA 820–2003 Standard for Fire Protection in Wastewater Treatment and Collection Facilities.

Comments to the appendices. OSHA received a comment to reference other national consensus standards in Appendix A, like ANSI Z490.1 and ANSI Z244.1, to help employers with new training requirements in electrical installations (Ex. 3–5). These voluntary consensus standards offer benefits in guiding employers on establishing appropriate training procedures for their employees. The national consensus standards listed in Appendix A are there to be used as a guideline to help employers with implementing the requirements for electrical installation and safe work practices and procedures in Subpart S. OSHA has reviewed both standards and has added them to the list of voluntary standards in the appendices.

R. Powered Platforms for Building Maintenance

Mandatory Appendix D to § 1910.66, powered platforms for building maintenance, applies to powered platforms installed between August 28, 1971, and July 23, 1990. Paragraphs (c)(22)(i) and (c)(22)(vii) in that appendix incorporate the 1971 NEC by reference. OSHA is referencing Subpart S instead. The final rule, which would replace the highly specification-oriented NEC with the performance-oriented Subpart S, will make the standard more flexible for employers maintaining these platforms but will retain the protection currently afforded employees.[53] In addition, employers will no longer need to refer to the NEC to determine how to comply with OSHA's standard for powered platforms. This change is deregulatory in nature and should not result in significant costs to employers.

OSHA received no comments in response to this proposed change. Consequently, it is being carried without change into the final rule.

VI. Final Economic and Regulatory Screening Analysis

A. Existing Versus Final Rule

The final rule revises and updates the provisions contained in Sections 1910.302–1910.308 and 1910.399 of the existing Subpart S electrical installation standard. The original version of Subpart S, adopted under § 6(a) of the OSH Act, incorporated the 1971 National Electrical Code (NEC) by reference. In 1981, OSHA replaced the incorporation by reference with updated provisions based on the 1979 National Fire Protection Association (NFPA) 70E committee recommendations. The 1981 version relied on the 1978 NEC. The rulemaking will revise and update the OSHA electrical installation standard to be consistent with most of the NFPA 70E recommendations developed in 2000, which are based on the 1999 NEC, and to update requirements for new electrical installations.

OSHA has conducted a detailed comparison of the existing and final rules in order to determine the extent to which the provisions of the final rule will increase compliance costs. Table 7 summarizes the changes associated with the provisions of the final rule that have cost implications. OSHA's comparative analysis indicates that the changes in the final rule fall into four categories: (1) Changes in hardware specifications that are consistent with NEC requirements; (2) changes in installation practices that are consistent with current, normal and customary installation practices routinely followed by licensed electricians; (3) clarifications of existing requirements that do not add additional obligations and/or allow greater flexibility for achieving compliance; and (4) requirements that may require

[52] OSHA had proposed to add an additional national consensus standard to the list, ANSI/UL 2279–1997, Electrical Equipment for Use in Class I, Zone 0, 1 and 2 Hazardous (Classified) Locations. This standard is no longer active, because UL has added zone-related provisions to other of its standards on equipment for hazardous locations. Therefore, OSHA has not included this standard in Appendix A in the final rule.

[53] Employers who make minor modifications to these platforms would thus be required to follow Subpart S rather than the 1971 NEC. Newer installations and major modifications of older platforms are already required to meet Subpart S with respect to the platform's electrical wiring and equipment.

significant changes in electrical system and equipment installation practices.

The first three categories of changes introduced by the final rule are not expected to result in any additional costs. Category 1 changes are not expected to increase costs because virtually all equipment manufacturers routinely follow current NEC requirements regarding hardware specifications. Category 2 changes are not expected to result in any increase in compliance costs since virtually all licensed electricians routinely follow NEC requirements for installing electrical systems and equipment. Category 3 changes do not add any new installation or work practice requirements, but simply restate or eliminate existing requirements.

Regarding Category 4, a number of changes indicated by the final rule correspond to revisions to the NEC made prior to 1999. Because these changes have been in the NEC since the previous edition (1996), they are believed to represent widespread current industry practice. Therefore, these changes are not expected to result in increased compliance costs. Moreover, construction requirements usually imposed by mortgage lenders and insurance carriers, as well as installation practices routinely followed by licensed electricians (given their formal training), are generally consistent with the NEC requirements. In sum, there is a subset of Category 4 changes that can be assumed to be equivalent to the Category 2 changes described above. Only those Category 4 changes that represent additions or revisions in the 1999 NEC (to the 1996 NEC) are expected to potentially result in any increase in compliance costs.

As noted, many Category 4 changes are not expected to increase compliance costs. In order to avoid having employers incur the costs of retrofitting the existing electrical systems and equipment in their buildings and facilities, OSHA has identified (in § 1910.302(b)(4)) the substantive new provisions in the final rule, and then excluded (grandfathered) all existing electrical systems and equipment installations from having to comply with these new requirements. These provisions will only apply to new installations (that is, electrical systems and equipment installed for the first time, as well as installations that represent a major replacement, modification, repair, or rehabilitation of an existing electrical system) made after the effective date of the standard. Of the new provisions identified in § 1910.302(b)(4), there are 14 provisions (or sets of related provisions) in Category 4 that were added or last revised in the 1999 NEC. A number of these provisions represent changes in design and/or operating practices. OSHA believes that with the appropriate lead time (that is, sufficient delay in the effective date of the final rule), these provisions should not result in any incremental costs because these requirements can be reviewed and considered, and the electrical installation practices altered as necessary, prior to any work being performed. For instance, the requirement in § 1910.303(f)(4) for disconnecting means to be capable of being locked in the open position can be met through selecting appropriate equipment in the installation design phase of a project. The feature required by this provision is already available in new equipment. OSHA sees no appreciable difference in cost between a disconnecting means that is capable of being locked in the open position and one that is not. Other provisions, such as § 1910.303(g)(1)(vii), which requires certain electric equipment to be installed in dedicated space, involve facility layout that can be met with no appreciable cost impact as long as the requirement is taken into consideration during the installation design phase of a project.[54] The final rule provides employers with a 6-month delay in effective date, in part, so that they can incorporate such considerations during the design of new electrical installations. (See section XII, Effective Date and Date of Application, later in this preamble.)

In addition to the provisions identified in § 1910.302(b)(4), there are also new provisions identified in § 1910.302(b)(2) and (b)(3) of the final rule that apply to: (1) Electrical system and equipment installations (either first time or major replacement, modification, repair, or rehabilitation) made after March 15, 1972; and (2) electrical system and equipment installations (either first time or major replacement, modification, repair, or rehabilitation) made after April 16, 1981, respectively. Reviewing the provisions identified in § 1910.302(b)(2) and (b)(3) of the final rule, there are 13 new provisions (or sets of related provisions) in Category 4 that were added or last revised in the 1999 NEC. Table 7 also lists those provisions with cost implications. Again, a number of these 13 new provisions represent changes in design or operating practice rather than new equipment requirements, and as discussed earlier, are not expected to result in any incremental costs as long as there is sufficient delay in the effective date of the final rule.

OSHA has examined other new provisions for possible cost impacts. First, § 1910.302(b)(1) of the existing and final rule identifies those provisions (that is, specific sections in the standards) that all new and existing electrical system and equipment installations must meet regardless of the installation date. For these provisions in the existing and final rule, there is no grandfathering of older, existing electrical system and equipment installations. However, OSHA has concluded that § 1910.302(b)(1) imposes no new, substantive Category 4 requirements for existing electrical systems and equipment installations. Further, while § 1910.302(b)(1) does add new coverage from § 1910.307, only documentation of hazardous locations is a totally new requirement, and the documentation for the division system only applies to installations made or overhauled after the effective date. The rest of the new provisions in § 1910.307 allow employers to continue using the division system or to implement an alternative zone system for classifying hazardous locations containing flammable gases or vapors. They should not result in any additional costs unless employers voluntarily choose to abandon their present division system in favor of the alternative zone system. Finally, there are new provisions not contained in the existing OSHA electrical installation standard that were originally in the 1971 NEC and were enforced by OSHA between March 15, 1972, and April 16, 1981. The latest version of NFPA 70E reincorporated these provisions. (For a full explanation, see the discussion of final § 1910.302(b)(2), in section V, Summary and Explanation of the Final Standard, earlier in the preamble.) OSHA believes that these provisions represent widespread current industry practices, because they have been part of every version of the NEC since 1971, including the 1999 and 2002 editions, and will not impose any additional cost.

B. Potentially Affected Establishments

The electrical safety standard is based primarily upon the 2000 NFPA 70E recommendations, which, in turn, are based on the 1999 NEC. Consequently, companies that are installing electrical systems and equipment in their facilities in locations where the 1999 (or 2002) NEC is currently being followed

[54] For example, a lighting fixture installed over a panelboard must be more than 1.83 m above the floor. It should not cost significantly more to install the fixture at such a height than it would to install it at a lower one.

will not be further impacted by OSHA's rulemaking with respect to new installations. Further, given that there are no new, substantive Category 4 provisions in the rule that are mandatory for all existing electrical system and equipment installations (see above discussion), these provisions will not result in any economic impact for existing installations, until they are replaced, repaired, and/or renovated.

In order to estimate the number of employers potentially impacted by the rulemaking, OSHA has identified the States and municipalities that currently mandate the 1999 (or 2002) National Electrical Code (NEC), that currently mandate using an earlier NEC, or that have no mandated statewide electrical code pertaining to new installations.[55] These states were identified using information contained in the Directory of Building Codes and Regulations, by City and State (National Conference of States on Building Codes and Standards, NCSBCS, 2002). In sum, 38 of the 50 States have already passed mandatory minimum building or fire codes specifying that new construction (including new electrical installations) must meet or exceed the requirements of the 1999 (or 2002) National Electrical Code (NEC).[56] Thus, OSHA assumes that employers in the covered industries in all locations in these 38 States (except for Baltimore, MD) will be unaffected by OSHA's rulemaking with respect to new installations. These States (with the particular NEC indicated) are listed in Table 5:

TABLE 5.—STATES WITH BUILDING OR FIRE CODES THAT MEET OR EXCEED THE 1999 NATIONAL ELECTRICAL CODE

Alaska
Arkansas
California
Colorado
Connecticut
Delaware
Florida
Georgia
Idaho
Indiana
Kentucky
Maine
Maryland
Massachusetts
Michigan
Minnesota
Montana
Nebraska
New Hampshire
New Jersey
New Mexico
New York
North Carolina
North Dakota
Ohio
Oklahoma
Oregon
Pennsylvania
Rhode Island
South Carolina
South Dakota
Tennessee
Utah
Vermont
Washington
West Virginia
Wisconsin
Wyoming

Moreover, 16 large cities in other States have also adopted the 1999 NEC. Therefore, employers in the covered industries in these municipalities are also expected to be unaffected by OSHA's rulemaking with respect to new installations. These cities are listed in Table 6:

TABLE 6.—CITIES THAT HAVE ADOPTED THE 1999 NATIONAL ELECTRICAL CODE

Austin, Texas
Chicago, Illinois
Dallas, Texas
Des Moines, Iowa
El Paso, Texas
Forth Worth, Texas
Honolulu, Hawaii
Houston, Texas
Jackson, Mississippi
Kansas City, Missouri
Las Vegas, Nevada
Phoenix, Arizona
San Antonio, Texas
St. Louis, Missouri
Tucson, Arizona
Wichita, Kansas

Further, the State of Alabama has adopted a limited mandatory minimum code, which, in effect, requires that hotels, schools, and movie theaters follow the 2002 NEC. Therefore, in this analysis, hotels, schools, and movie theaters in Alabama have been included with the group of 38 States and 16 large cities (described above) that currently follow the 1999 (or 2002) NEC.

The remaining 12 States (or portions of these States) that would likely be affected by OSHA's rulemaking can be separated into two subgroups: (1) States or municipal jurisdictions that have adopted the 1996 version of the NEC; and (2) States that have not adopted any statewide electrical code covering all non-government-owned buildings or facilities (that is, private sector installations). For group 1, to the extent that any of these jurisdictions adopt a later version of the NEC before this final rule goes into effect, annual compliance costs will likely be lower than estimated below.

Five States and three cities fall into the first of the two subgroups described above. These include all locations in Louisiana and Virginia, as well as portions of Arizona, Iowa, and Nevada (that is, all locations in these three States excluding the four large cities in these States that have adopted the 1999 NEC, as indicated in the list above). The three large cities in the first subgroup include Baltimore, MD, Birmingham, AL (excluding hotels, schools, and movie theaters), and Washington, DC. Employers in these locations may be affected to the extent that the 1999 NEC, which is the basis for the rulemaking, differs from the 1996 NEC.

Many of the new provisions in the final rule, including those in Category 4 that have potential cost implications for new electrical systems and equipment installations, date back to the 1996 NEC or to an NEC prior to 1996. Thus, for these provisions, employers in locations now requiring that the 1996 NEC be followed will not be affected by OSHA's rulemaking with respect to new installations.

Seven States have not yet adopted any statewide electrical code that applies to all private sector employers. These States include: Alabama (excluding hotels, schools, and movie theaters), Hawaii, Illinois, Kansas, Mississippi, Missouri, and Texas. Employers in these States are expected to be the most affected (of the three subgroups) by OSHA's rulemaking, since no Statewide electrical code is currently required. For these seven States, OSHA's existing electrical installation standard, which is primarily based on the 1971 and 1978 NECs, governs.[57] Below the Statewide level, it is not clear to what extent local jurisdictions have passed local electrical ordinances that exceed the 1971 and 1978 NECs and are consistent with the

[55] In States with no mandated electrical code pertaining to new installations, OSHA's existing standards, which are primarily based on the 1971 and 1978 NECs, are the governing rules. (In State Plan States, each State has adopted a standard that Federal OSHA has found to be at least as effective as the Federal standard. For all practical purposes, this means that OSHA's existing standard is the governing standard unless the State has adopted a more stringent standard.)

[56] Maryland has adopted the 1999 NEC as a Mandatory Minimum Code, exempting Baltimore from compliance. Generally when a state updates these mandatory minimum requirements, the new requirements apply only to new facilities or installations.

[57] Note that of these seven States, Hawaii is the only State Plan State. Hawaii has adopted the Federal standard.

1999 NEC. While it is likely that some local jurisdictions within these states enforce the 1999 (or 2002) NEC, OSHA's analysis treats these States as though they are not in compliance with either the 1999 or 2002 NEC for purposes of analysis. As a consequence, the estimated compliance costs are likely to be overstated.

Using data from the U.S. Department of Commerce's 1997 County Business Patterns database, OSHA has estimated the total number of affected establishments and employment in those establishments for the 58 two-digit SICs covered by the general industry electrical safety installation standard.[58] In addition, the number of establishments and employment that are already subject to the 1999 NEC, the 1996 NEC, the 1990 NEC, and no statewide electrical code, are also estimated. For those cities (identified above) that are currently following a particular electrical code, OSHA has estimated the number of establishments and employment in these cities using, as a surrogate, the data for the county in which the cities are located.

The data indicate that there are an estimated 5.6 million establishments with 89.8 million employees in the industries covered by the general industry electrical safety installation standard. About 84.7 percent of the establishments, employing about 85.3 percent of the employees, are in States or cities that have adopted the 1999 (or 2002) NEC. Approximately 6.3 percent of both the establishments and employees are in States or cities that have adopted the 1996 NEC. The remaining approximately 9.0 percent of the establishments, employing about 8.4 percent of the employees, are in States (excluding certain cities in these States) that have not adopted a statewide electrical code applicable to private sector employers. Table 8 summarizes these findings.

C. Benefits

Occupational fatalities associated with electrical accidents remain a significant and ongoing problem. The final rule would benefit employees by reducing their exposure to electrical hazards thereby reducing both fatal and nonfatal injuries.

Table 9 presents data from the Survey of Occupational Injuries and Illnesses and the Census of Fatal Occupational Injuries on the number of work-related injuries and deaths in private industry attributed to contact with electrical current for 1992–2004. While the numbers of injuries and deaths appear to have declined, this decline has not been consistent throughout the time for which data are available. Electrical-related injuries increased between 1992 and 1994, then declined for 1995 to 1997. For 1998 and 1999, injuries again increased. Note that the percentage of occupational injuries associated with electrical hazards has remained essentially constant throughout 1992 to 2004. The number of deaths associated with contact with electrical current declined in 1993, but rose during 1994 and 1995. Deaths dropped in 1996, but rose again in 1997 and 1998. As a percentage of total occupational fatalities, death due to electrocution appears to have remained constant or declined slightly. However, contact with electrical current remains a significant source of occupational fatality, accounting for 4.4 percent of total occupational fatalities in 2004.

For more than 30 years, electrical hazards have been a target of OSHA rules. This rule will help to further reduce the number of deaths and injuries associated with electrical accidents, and ensure that a downward trend in these incidents is sustained.

To determine the extent to which the standard may reduce the number of deaths attributable to electrical accidents, OSHA examined its accident investigation reports for the States without any statewide electrical code.[59] The most recent and complete reports cover 1990–1996, and provide detailed information on the cause of fatal electrical accidents. The accident cause can be used to ascertain whether the death would have been prevented by compliance with the final rule. As an initial screen, OSHA reviewed the reports for accidents that could have been prevented through the use of a GFCI. While OSHA expects that other provisions of the revised standard potentially will reduce deaths due to electrical accidents, this initial screen focused on GFCI-related accidents since they are relatively easy to isolate using a key word search through all reports. Thus, the accident report analysis is conservative in the sense that it likely understates the number of deaths preventable under the revision to Subpart S.

OSHA found that there were at least nine deaths in the seven States that lacked a statewide electrical code during 1990–1996, or an average of 1.3 deaths per year that could have been prevented with the use of a GFCI. Based on EPA's estimate of a value of $6.1 million for a statistical life, the estimated 1.3 lives saved per year (that is, between 1 and 2 lives saved per year) under the final rule would translate to an annual benefit of $7.9 million (ranging from $6.1 million to $12.2 million).[60] As noted above, the monetized benefits understate total benefits since they do not cover all potentially preventable deaths. Moreover, they do not account for any preventable nonfatal injuries.

In addition to quantifiable potential benefits, this update to OSHA's electrical standards yields important unquantified benefits. The revised standard potentially reduces industry confusion and inefficiency associated with the current standard, which is out of date with today's technology. While OSHA has a long-standing policy of permitting employers to comply with more current versions of national consensus standards to the extent the more current version is as protective as the older version, this does not address all the concerns with the outdated standard. The older electrical standards may not address the hazards associated with newer equipment and machinery, leaving employers unsure which requirements presently apply. For example, the final standard contains requirements for electric equipment installed in hazardous locations classified under the zone classification system, which is not addressed in the existing standard. (See the summary and explanation of zone classification in section N. earlier in the preamble.) The update to Subpart S will reduce or eliminate these problems.

D. Estimation of Compliance Costs

OSHA adopted a conservative approach to estimating compliance costs, and consequently, the estimates reported below are likely to overstate actual compliance costs. In summary, OSHA did not estimate any cost savings associated with the final rule, even

[58] These 58 SICs include employers in shipyard employment, longshoring, and marine terminals. Consistent with the preliminary analysis, OSHA in this final analysis has grouped affected industries according to the 1987 Standard Industrial Classification System. For industry coding under the North American Industry Classification System (NAICS), see NAICS, Executive Office of the President, Office of Management and Budget, 1997 and 2002, or *http://www.census.gov/epcd/www/naics.html.*

[59] Some cities within these States have adopted the 1999 (or later) NEC, and these cities were excluded when examining the accident report data.

[60] *See* EPA's Guidelines for Preparing Economic Analyses, EPA 240–R–00–003, September 2000. Note that the $6.1 million is in 1999 dollars. If this figure is updated for inflation using the CPI as EPA indicates is appropriate, the estimated 1.3 lives saved per year (between 1 and 2 lives saved per year) would translate to an annual benefit of $9.4 million (between $7.2 million and $14.4 million) in 2005 dollars.

though many new, potentially less costly alternative compliance methods are incorporated in the final rule. For example, as noted above, the rule will permit electric equipment in Class I hazardous locations to be installed under the zone classification system, which is not addressed in the existing standard. Because the hazardous locations provision potentially reduces industry confusion and inefficiency associated with the current standard, costs savings are likely.

For all provisions with the exception of § 1910.304(b)(3)(ii) (GFCI protection for temporary wiring installations), cost estimates were developed on a project-level basis. This involved obtaining data on the number of construction and other major renovation, addition, and alteration projects performed annually in States and local jurisdictions that do not now mandate the 1999 NEC (or equivalent).[61] Table 10 summarizes the data on the number of projects potentially impacted by the final rule. In States and local jurisdictions that do not now mandate the 1999 NEC (or equivalent), the data indicate that there were a total of 29,306 project starts in 2001, consisting primarily (91 percent) of small projects under $3 million. Less than 0.5 percent of the projects were large projects over $25 million.

For § 1910.304(b)(3)(ii), compliance costs were estimated on an establishment-level rather than project-level basis. OSHA estimates that approximately 861,400 establishments are in locations that either are currently following the 1996 NEC or have not adopted a statewide electrical code applicable to private sector employers. These employers potentially are impacted by the final rule. Costs per provision were computed according to establishment size: establishments with fewer than 100 employees, establishments with 100–499 employees, and establishments with 500 or more employees.

All potentially impacted projects/establishments would not necessarily be affected by each and every provision, and some would not be affected at all in any given year. Thus, it was necessary to estimate the percentage of projects/establishments affected by each provision annually. This percentage, when multiplied by the number of potentially impacted projects/establishments yields the number of projects/establishments subject to each provision annually without considering baseline levels of compliance. Table 11 presents the estimated percentage of projects/establishments that actually would be affected by each provision annually. These estimates were based on experience and technical knowledge of electrical practices.

Baseline levels of compliance associated with each of the new provisions also were considered. Baseline levels of compliance were estimated for each provision by considering construction requirements imposed by mortgage lenders and insurance carriers and installation practices routinely followed by licensed electricians (given their formal training). (See the earlier discussion of categories of changes in the final rule.) These requirements and installation practices are generally consistent with the current NEC requirements. Moreover, it is expected that these requirements and practices generally become more prevalent as the size of the establishment or project increases. Table 12 presents the estimated percentages for baseline compliance rates. These estimates were based on experience and technical knowledge of electrical practices.

For each provision, estimates of labor and material costs were developed on a project level basis. Labor costs are based on an hourly wage rate of $20.44 for an electrician in the construction sector (SICs 15–17 (NAICS 236–238)) to perform the work (plus fringe benefits at 37 percent).[62] Costs for materials, which consist of labels, GFCIs, conduits, connectors, and outlets, are based on data in the Maintenance Direct Catalog of Lab Supply, Inc. (2001). Equipment costs were annualized assuming the useful life of the equipment is two years and an interest rate of 7 percent. Table 13 summarizes the key data and bases for the cost estimates.

OSHA received very few comments on the preliminary economic and regulatory flexibility screening analysis.

The National Petrochemical and Refiners Association (NPRA) stated in Ex. 3–2 that ''the cost merely to read and comprehend the ruling, and to train personnel, will be at least in the tens of thousands of dollars per facility.'' However, NPRA provided no material to substantiate this claim. OSHA believes that the final rule imposes no cost to comprehend or to train personnel, particularly given the widespread use of the 1999 and 2000 NEC.

CHS, Inc. stated, ''the proposed rule could result in several unit start-ups/shutdowns at farmer-owned petroleum refineries'' (Ex. 4–25). However, CHS did not explain how the new provisions in this standard would require additional outages to deenergize beyond those which could develop from compliance with the existing standard.

Although OSHA received no new data in response to the preliminary analysis, OSHA has slightly revised its economic model in order to make it more realistic and to reflect changes between the proposed and final regulatory text. For example, in assigning compliance costs to § 1910.304(b)(3), Ground-fault circuit interrupter protection for personnel, OSHA's final model predicts that a small percentage of projects will establish and implement an assured grounding conductor program where ground-fault circuit interrupter protection is not available. An example of a revision to the preliminary analysis that reflects real-world considerations is the addition in the final analysis of an explicit cost for legible marking of equipment to indicate that the equipment has been applied with a series combination rating, as required by § 1910.303(f)(5), Marking for series combination ratings.

In addition, the final rule contains some new provisions that were not in the proposed rule or that were revised from what was in the proposal. Three of those provisions potentially require modification of existing installations: (1) Final § 1910.304(a)(3), which prohibits a grounding terminal or grounding-type device on a receptacle, cord connector, or attachment plug from being used for purposes other than grounding, (2) final § 1910.304(g)(4)(iii), which no longer permits extensions of branch circuits to be grounded by connection to a grounded cold water pipe, and (3) final § 1910.304(g)(8)(iii), which no longer permits electric equipment to be grounded only by connection to the grounded structural metal frame of a building when any element of the equipment's branch circuit is replaced.

A prohibition against using grounding terminals and grounding-type devices for purposes other than grounding is already contained in existing § 1910.304(a)(3). Under the current standard, this provision applies to all electrical installations including major replacements, modifications, repairs, or rehabilitations made after March 15, 1972. In the final rule, OSHA is extending the application of this prohibition to installations made before that date. Wiring a receptacle, cord

[61] Data on new and other (major renovation, addition, and alteration) construction projects started annually between 1998 and 2001 are compiled by F.W. Dodge (Schriver, 2002). While construction projects serve as the basis for estimating costs, construction is not covered by the final standard. Rather, it is the particular product or output of the construction project that is covered.

[62] The wage rate data are for 2000, taken from the BLS (2001) 2000 National Occupational Employment Statistics (OES) Survey. Fringe benefit rate data are from BLS (2000) Employer Costs for Employee Compensation, March. USDL: 00–186.

connector, or attachment plug so that the grounding terminal or other grounding-type device is used for purposes other than grounding (for example, by connecting a circuit conductor to the grounding terminal) makes the electric equipment extremely unsafe, posing an immediate threat of electrocution. In addition, such an incorrect wiring connection renders the equipment unusable, and it would likely have already been changed. Consequently, it is extremely unlikely that violations of this rule exist in significant numbers, and OSHA has concluded that applying this provision to all existing installations will have little if any economic impact.

Existing § 1910.304(f)(3)(iii) permits connecting the equipment grounding terminal of grounding-type receptacles to a nearby grounded cold water pipe for extensions of existing branch circuits that do not have an equipment grounding conductor. In the final rule, OSHA is requiring that, when any element of this branch circuit is replaced, the entire circuit include an equipment grounding conductor that complies with all other provisions of paragraph (g) of § 1910.304.[63] This change only affects a small percentage of branch circuits extended after March 15, 1972, the date the provision went into effect. The existing requirement makes the equipment grounding path dependent upon the metallic continuity of the cold water piping and upon the earth for the electric current's return path back to the electric source. If a ground fault occurs at electric utilization equipment (for example, a portable cord-connected electric drill with a grounding-type attachment plug) plugged into a grounding-type receptacle and if the continuity of the water pipe is interrupted by a section plastic pipe or by another means, the electric equipment becomes extremely lethal, posing an immediate threat of electrocution. Additionally, the practice of using metallic water pipes as an equipment grounding conductor poses an electrocution hazard to plumbers, pipe fitters, and other employees working on the system who might unknowingly interrupt a path of fault current flowing through the piping. The return current path in both instances is through the employee instead of through a reliable equipment grounding conductor. Employers have become aware that using cold water plumbing for grounding is a poor practice and most have already corrected this condition, which is a violation of recent editions of the NEC[64]. According to Karl M. Cunningham of Alcoa (Ex. 4–4), the permission to use a cold water pipe near the equipment was clearly removed from the NEC for many Code cycles, including the 2002, 1999, 1996, and 1993 editions.

Because the NEC has not allowed this practice for over 10 years, few employers use this provision in the existing rule due to the known hazards. Therefore, it is unlikely that violations of this rule exist in significant numbers. Even then, employers who are still using cold water piping to ground branch-circuit extensions are only required to upgrade them when they are replacing one of the branch circuit extension's elements. The installation of the equipment grounding conductors would be coincidental with the modification work; and, thus the cost of compliance would be incidental. Hence, OSHA has concluded that requiring this provision for all modifications made to existing installations will impose no appreciable costs on employers.

A prohibition against maintaining the grounded structural metal framing of a building for purposes of grounding electric equipment is contained in existing § 1910.304(f)(6)(ii). This provision currently applies only to installations made after April 16, 1981. In the final rule, § 1910.304(g)(8)(iii), OSHA is also applying this prohibition to installations made or designed before April 16, 1981, when any element of the equipment's branch circuit is replaced.

Metal frames of buildings provide a poor substitute for an equipment grounding conductor. Installations that might have initially provided a permanent, continuous, and effective equipment grounding path fail to function adequately as time passes. If a fault occurs in the electric equipment an extremely lethal condition exists, posing an immediate threat of electrocution, since the return current path is through the employee instead of the intended equipment grounding path. As brought forth by one commenter (Ex. 4–18) and stated in the preamble discussion for proposed § 1910.304(g)(7)(ii) (final § 1910.304(g)(8)(ii) and (g)(8)(iii)), this practice has been prohibited for ac circuits since the 1978 edition of the NEC. Thus, this change only affects a small percentage of branch circuits extended after March 15, 1972, the date the provision went into effect and until 1979 when the NEC prohibition applied.

Many employers recognized the safety hazards and the operating anomalies of grounding utilization equipment to the structural metal framing of buildings. Consequently, they have already abandoned the practice. Therefore, it is extremely unlikely that violations of this rule exist in significant numbers. After all, this practice has been banned for over a quarter of a century by the NEC. OSHA has concluded that requiring the installation of an equipment grounding conductor instead of allowing the structural metal frame of a building to serve as the equipment grounding conductor for all modifications to existing installations will have no appreciable cost impacts.

The final rule also includes a new provision, final § 1910.304(b)(3)(ii)(C), that allows implementation of an assured equipment grounding conductor program during maintenance, remodeling, or repair of buildings, structures, or equipment or during similar construction-like activities when GFCIs are not available. OSHA has added costs for this provision in the analysis, as explained below.

Final § 1910.304(b)(3)(ii)(B) requires receptacles other than 125-volt, single-phase, 15-, 20-, and 30-ampere receptacles that are not part of the permanent wiring of the building or structure and that are in use by personnel to have ground-fault circuit-interrupter protection for personnel. OSHA recognizes that it may be impossible for employers to comply with this requirement for GFCI protection for circuits operating at voltages above 125 volts to ground. For instance, portable electric welding units for the repair of major pieces of equipment such as industrial boilers and other massive units of industrial equipment generally require a 480-volt power connection rated 30 amperes or more. At these ratings, GFCI protection for personnel may not be feasible since it is not presently available for all branch-circuit voltage and current ratings. Therefore, the final rule permits an assured equipment grounding conductor (AEGC) program as an alternative.[65]

Although OSHA believes that the AEGC program costs more to implement than GFCI protection for personnel (equivalent to a unit cost of $110 instead of $55) it could reduce compliance costs for employers when compared to hard-

[63] For example, 1910.304(g)(4)(iii) requires that when any element of a branch circuit extension is replaced, the entire branch circuit shall include an equipment grounding conductor.

[64] For example, a metallic cold water pipe is not listed in Section 250.118 of the 2002 NEC as a type of equipment grounding conductor.

[65] Final § 1910.304(b)(3)(ii)(C) requires the employer to establish and implement an assured equipment grounding conductor program covering cord sets, receptacles that are not a part of the building or structure, and equipment connected by cord and plug that are available for use or used by employees on those receptacles.

wired methods.[66] OSHA believes that about five percent (one in twenty) of all temporary electric circuits may not be serviceable with GFCI protection for personnel at the higher current and voltage ratings and would require the AEGC program. The need to connect electric equipment with ratings other than 125 volts, single phase, 15, 20, and 30 amperes, or 250 volts, single phase, 15 and 20 amperes[67] increases as the size of the project increases. Nearly all temporary power requirements for smaller-sized projects, those with contract values under $3 million, would be serviceable with GFCI-protected receptacles or from nearby receptacles that are a part of the existing building structure. Smaller projects tend to take up minimal plant real estate. The work area is sandwiched among other facility equipment and is contained within the confines of the existing plant. Few, if any, of these projects would have need for the higher-power or higher-voltage equipment. Even if a project does need such equipment, these facilities typically have existing, permanently wired electric power receptacles that are capable of supporting loads at higher voltage and current ratings. Such receptacles are typically located throughout the plant on 30-meter, maximum, intervals allowing for easy connection of portable electric equipment with 15-meter flexible cords. Consequently, OSHA estimates that the number of smaller-sized projects that require the AEGC program is negligible.

As many as half of all medium-sized projects, those ranging from $3 million to $25 million, would potentially require the AEGC program. These projects can include a sizable block of real estate such that the cords on portable equipment will not reach existing, permanently wired receptacles.

Nearly all major projects, those larger than $25 million and encompassing significant plant real estate, are likely to use an AEGC program to comply with the standard.

OSHA estimates that, at projects that would be required to use the AEGC program, they would be needed for only about five percent of temporary electric circuits. The remaining 95 percent of all temporary electric circuits can be protected by GFCIs. Over the entire universe of employers affected by the final rule, the estimated total cost of using an AEGC program instead of GFCIs is approximately $5,300.

Table 14 presents the cost estimates for the final rule. The total annual incremental compliance costs associated with the new provisions in the final rule, for new electrical system and equipment installations, are estimated to be $9.6 million. The overwhelming majority of costs, 84.4 percent, are associated with § 1910.304(b)(3)(ii), Ground-fault circuit interrupter protection for personnel during temporary wiring installations. The total cost for this requirement is based upon the following unit estimates and assumptions:

(1) GFCI power station or cord, initial cost = $55 (annualized cost = $30.42);

(2) the number of required units ranges from two for establishments with less than 100 employees, to 10 for establishments with 100 to 499 employees, to 50 for establishments with more than 500 employees;

(3) the percentage of affected establishments ranges from 30 percent for the smallest establishments to 100 percent for the largest establishments (Table 11); and

(4) baseline industry compliance of 50 percent for the smallest establishments to 95 percent for the largest establishments (Table 12).

Some of the costs and exposures to temporary wiring could potentially be incurred by employers performing construction work rather than general industry work. Temporary wiring for construction work is already covered under Subpart K of Part 1926; and, consequently, this analysis likely overestimates the incremental costs associated with the revisions to Subpart S.

E. Technological and Economic Feasibility

As noted previously, the final rule incorporates the NFPA 70E recommendations developed in 2000, which are based on the 1999 NEC. The NFPA 70E Committee has updated the document in accordance with revisions to the NEC, which periodically recodifies acceptable electrical practices as a national consensus standard. More than 80 percent of establishments covered by the final rule are located in areas that currently mandate adherence to these recommendations or the 1999 or more stringent version of the NEC. Moreover, the vast majority of employers comply with the NEC in the absence of any legal obligation.[68] Thus, most potentially affected parties already are in compliance with the final rule, which clearly demonstrates that it is technologically feasible. The costs of the rule are also extremely low, as discussed earlier in this section of the preamble. These costs do not threaten the long-term profitability or competitive structure of affected industries. Therefore, the final rule is also economically feasible.

F. Regulatory Flexibility Screening Analysis and Regulatory Flexibility Certification

In order to determine whether a regulatory flexibility analysis is required under the Regulatory Flexibility Act, OSHA has evaluated the potential economic impacts of this action on small entities. Table 15 presents the data used in this analysis to determine whether this rule would have a significant impact on a substantial number of small entities.

First, compliance costs were computed on a per establishment basis, which required consideration of the number of establishments potentially impacted. The analysis of County Business Patterns data discussed above indicated that approximately 861,400 establishments are in local jurisdictions in the 12 States that are either currently requiring compliance with the 1996 NEC or have not adopted a statewide electrical code applicable to private sector employers. Regarding the documentation provisions for new installations in hazardous locations (§ 1910.307(b) in Table 14), only industries that handle flammable and/or combustible liquids, vapors, gases, dusts, and/or fibers will be impacted. OSHA identified these industries by reviewing data on § 1910.307 citations issued between October 2000 and September 2001 (available on the OSHA website at *http://www.osha.gov/oshstats/*) and IMIS accident data from 1994 to 2001 indicating § 1910.307 citations (OSHA, 2001). OSHA estimated that approximately 441,400 establishments with hazardous locations are in local jurisdictions in the 12 States that either are currently following the 1996 NEC or have not adopted a statewide electrical code applicable to private sector employers. These are the establishments potentially impacted by the hazardous locations provision. The remaining provisions potentially affect

[66] Employers have two alternatives when GFCI protection for personnel is required for receptacles that are not part of the permanent wiring of a building or structure: (1) Implement an assured equipment grounding conductor program or (2) provide a hard-wired installation, in which the equipment is wired directly to the circuit conductors, obviating the need for a receptacle outlet.

[67] GFCI protective devices for personnel protection may not readily available above 30 amperes at 125 volts, above 20 amperes at 250 volts, or at higher voltages.

[68] As noted previously, construction requirements imposed by mortgage lenders and insurance carriers and installation practices followed by licensed electricians (given their formal training) are reasons to expect that some employers comply with the NEC in the absence of any legal obligation.

all 861,400 establishments in the 12 States as noted above.[69]

OSHA assumed for purposes of conducting the regulatory flexibility screening analysis, that small firms, on average, will conduct the same type and size of projects as larger establishments. This is a conservative assumption, since it is more likely that smaller establishments will tend to perform small sized, less costly projects. Consequently, OSHA applied an average cost per establishment in analyzing the effect on small entities. The average cost per establishment was computed by dividing the total costs reported in Table 14 by the number of affected establishments reported in Table 8. For Provisions 1 to 5 and 7, the cost per establishment is $10.10 and for Provision 6, the cost per establishment is $1.92. Thus, for industries that handle flammable and/or combustible liquids, vapors, gases, dusts, and/or fibers, the total cost per establishment is estimated to be $12.02.

OSHA guidelines for determining the need for regulatory flexibility analysis require determining the regulatory costs as a percentage of the revenues and profits of small entities. OSHA derived estimates of the profits and revenues using data from U.S. Census and Dun and Bradstreet. In defining a small business, OSHA followed Small Business Administration (SBA) criteria for each sector. For many of the affected industries, the SBA small business criteria are determined directly by the number of employees. But for those industries where the SBA small business criteria are not determined by the number of employees (but rather by annual sales), the sales-based criteria were converted to employment-based criteria. Specifically, an employment-based firm size standard was determined by first calculating an employment level, based on the industry average annual receipts per employee, which would be sufficient to produce a total sales amount per firm consistent with the SBA sales-based firm size standard.

As shown in Table 15, at worst, compliance costs represent 0.005 percent of the revenues (for SIC 72, Personal Services) and 0.15 percent of profits (for SIC 56, Apparel and Accessory Stores). On average (computed by weighting by number of establishments), compliance costs constitute 0.002 percent of revenues and 0.048 percent of profits. Based on this evaluation, OSHA certifies that this rule will not have a significant economic impact on a substantial number of small entities.[70]

TABLE 7.—CHANGES TO THE EXISTING STANDARD WITH COST IMPLICATIONS

Final rule [1]	Comments on cost impact	Types of establishments/ projects affected	Basis for estimating costs	Provisions identified in the final rule § 1910.302(b)(4) [2]
1910.303(f)(5)	Requires the purchase and installation of labels.	All Establishments All Projects.	Projects	X
1910.303(h)(5)(iii)(B)	Requires the purchase and installation of signs.	All Establishments All Projects.	Projects	
1910.304(b)(1)	Requires the purchase and installation of labels and identification of branch circuits.	All Establishments All Projects.	Projects	X
1910.304(b)(3)(i)	Requires the purchase and installation of GFCI for bathrooms and rooftops.	All Establishments All Projects.	Projects	
1910.304(b)(3)(ii)(A) and (b)(3)(ii)(B).	Requires that each affected facility purchase GFCI equipment (power stations or extension.	All Establishments All Projects.	Establishments	
1910.304(b)(3)(ii)(C)	Requires that the facility establish and implement an assured equipment grounding conductor program.	All Establishments All Projects.	Establishments	
1910.306(c)(6)	Requires the purchase and installation of signs.	All Establishments All Projects.	Projects	X
1910.306(j)(1)(iii)	Change in design impacts construction cost (near universal compliance assumed).	Real Estate Development and Dwelling Projects.	Projects	X
1910.306(k)(4)(iv)	Requires the purchase and installation of labels.	Carnivals, Circuses, Fairs, and Similar Events.	Projects	X
1910.307(b)	Facility owner must develop documentation.	Industrial Establishments All Projects.	Projects	X
1910.308(b)(3)	Requires the purchase and installation of signs.	All Establishments All Projects.	Projects	X
1910.308(e)(1)	Change in facility design and additional materials and installation cost.	All Establishments Large Projects.	Projects	

[1] Note: In the proposal, §§ 1910.303(e)(2)(ii) and 1910.308(a)(5)(vi)(B) and (d)(2)(ii) were mistakenly identified as paperwork requirements imposing a cost burden on employers. The costs for the labeling required by these provisions is borne by the manufacturers as usual and customary. In addition, proposed § 1910.304(b)(3) has not been carried forward into the final rule. Consequently, this Final Economic Analysis does not include costs for these four requirements. However, OSHA has determined that final §§ 1910.303(f)(5), 1910.306(c)(6) and (k)(4)(iv), and 1910.308(b)(3) do impose paperwork-associated costs on employers, but they were not included in the Preliminary Economic Analysis. Therefore, this Final Economic Analysis does include costs for these four provisions.

[2] Note: Provisions listed in § 1910.302(b)(4) only apply to new installations.

[69] For § 1910.307(b), OSHA's calculation of per-establishment costs and impacts is based on an estimated 441,400 affected establishments. For all other provisions of the final standard, OSHA's calculation of per-establishment costs and impacts is based on an estimated 861,400 affected establishments.

[70] OSHA also examined the situation where all compliance costs accrue to the construction sector (in SIC 1731, Electrical Services). In this case, costs constitute 0.04 percent of revenues 1.3 percent of profits. Thus, even if all costs are assigned to construction, the proposed regulation will not have a significant impact on small entities.

TABLE 8.—ESTABLISHMENTS AND EMPLOYMENT AFFECTED BY THE FINAL STANDARD, BY VERSION OF NEC ADOPTED

Applicable version of NEC	Establishments		Employment	
	Number	Percent of total	Number	Percent of total
1996	[1] 0.4	6.3	[1] 5.6	6.3
1999 or 2002	[1] 4.8	84.7	[1] 76.6	85.3
None	[1] 0.5	9.0	[1] 7.6	8.4
Total	[1] 5.6	100	[1] 89.8	100

Source: U.S. Dept. of Labor, OSHA, Office of Regulatory Analysis, based on 1997 County Business Patterns (U.S. Census Bureau) database.
[1] In millions.

TABLE 9.—FATAL AND NONFATAL OCCUPATIONAL INJURIES ATTRIBUTABLE TO CONTACT WITH ELECTRIC CURRENT (PRIVATE INDUSTRY)

Year	Number of injuries involving days away from work	Percent of Total nonfatal occupational injuries	Number of deaths	Percent of total fatal occupational injuries
1992	4,806	0.2	317	5.8
1993	4,995	0.2	303	5.4
1994	6,018	0.3	332	5.6
1995	4,744	0.2	327	6.0
1996	4,126	0.2	268	4.8
1997	3,170	0.2	282	5.0
1998	3,910	0.2	324	5.9
1999	4,224	0.2	259	4.7
2000	3,704	0.2	256	4.8
2001	3,394	0.2	285	4.8
2002	2,967	0.2	289	5.2
2003	2,390	0.2	246	4.4
2004	2,650	0.2	254	4.4

Source: U.S. Bureau of Labor Statistics, Survey of Occupational Injuries and Illnesses and the Census of Fatal Occupational Injuries (*http://www.bls.gov/iif/home.htm*).

TABLE 10.—CONSTRUCTION PROJECT STARTS IN 2001 FOR STATES THAT HAVE ADOPTED THE 1996 NEC OR DO NOT HAVE A STATEWIDE ELECTRICAL CODE

Building type	Size of project (contract value)			Total
	Less than $3 million (small)	$3–25 million (medium)	More than $25 million (large)	
Commercial and Public Buildings	15,219	1,490	45	16,754
Warehouses	1,659	204	8	1,871
Health Facilities and Laboratories	1,691	245	33	1,969
Funeral and Interment Facilities	45	.....	.....	45
Athletic and Entertainment Facilities	54	9	2	65
Auto, Bus, and Truck Service	797	47	.....	844
Residential Housing	1,491	169	6	1,666
Apartments, Hotels and Dormitories	2,505	269	24	2,798
Tanks	309	8	.....	317
Hydroelectric Power Plants	3	.....	.....	3
Natural Gas Plants	2	2	1	5
Gas, Water, and Sewer Lines	2,340	91	1	2,432
Manufacturing Facilities	447	84	6	537
Total	26,562	2,618	126	29,306

Source: William R. Schriver (2002), The University of Tennessee, Knoxville, Construction Industry Research and Policy Center, based on F.W. Dodge data on construction project starts for 2001.

TABLE 11.—ESTIMATED PERCENTAGES OF PROJECTS/ESTABLISHMENTS AFFECTED BY THE FINAL STANDARD

[By provision and project/establishment size]

Provision No.	Final rule	Description of requirement	Project/establishment size		
			Small (percent)	Medium (percent)	Large (percent)
1	1910.303(f)(5)	Marking for series combination ratings	50	50	50
2	1910.303(h)(5)(iii)(B)	Working Space and Guarding—Posting of Warning Signs	50	100	100
1a	1910.304(b)(1)	Branch Circuits—Identification of Multiwire Branch Circuits	50	50	50
3	1910.304(b)(3)(i)	Ground-fault circuit interrupter protection for bathrooms and rooftops.	100	100	100
4	1910.304(b)(3)(ii)(A) and (b)(3)(ii)(B).	Ground-fault circuit interrupter protection for temporary wiring installations.	30	80	100
4a	1910.304(b)(3)(ii)(C)	Assured equipment grounding conductor program for temporary wiring installations.	0	50	100
1b	1910.306(c)(6)	Identification and signs for elevators, dumbwaiters, escalators, moving walks, wheelchair lifts, and stairway chair lifts.	50	50	50
5	1910.306(j)(1)(iii)	Swimming Pools, Fountains, and Similar Installations—Receptacles.	20	80	100
1c	1910.306(k)(4)(iv)	Marking for single-pole portable cable connectors for parallel sets of conductors used in installations for carnivals, circuses, fairs, and similar events.	50	50	50
6	1910.307(b)	Hazardous (Classified) Locations—Documentation	60	80	100
1d	1910.308(b)(3)	Signs for emergency power systems	50	50	50
7	1910.308(e)(1)	Communication Systems—Protective Devices	5	60	100

Source: OSHA estimates, based on experience and knowledge of electrical practices.

TABLE 12.—ESTIMATED PERCENTAGES FOR BASELINE COMPLIANCE, BY PROVISION AND PROJECT/ESTABLISHMENT SIZE

Provision No.	Final rule	Description of requirement	Project/establishment size		
			Small (percent)	Medium (percent)	Large (percent)
1	1910.303(f)(5)	Marking for series combination ratings	25	25	50
2	1910.303(h)(5)(iii)(B)	Working Space and Guarding—Posting of Warning Signs	25	25	50
1a	1910.304(b)(1)	Branch Circuits—Identification of Multiwire Branch Circuits	25	25	50
3	1910.304(b)(3)(i)	Ground-fault circuit interrupter protection for bathrooms and rooftops.	50	95	95
4	1910.304(b)(3)(ii)(A) and (b)(3)(ii)(B).	Ground-fault circuit interrupter protection for temporary wiring installations.	50	95	95
4a	1910.304(b)(3)(ii)(C)	Assured equipment grounding conductor program for temporary wiring installations.	0	5	5
1b	1910.306(c)(6)	Identification and signs for elevators, dumbwaiters, escalators, moving walks, wheelchair lifts, and stairway chair lifts.	25	25	50
5	1910.306(j)(1)(iii)	Swimming Pools, Fountains, and Similar Installations—Receptacles.	60	90	90
1c	1910.306(k)(4)(iv)	Marking for single-pole portable cable connectors for parallel sets of conductors used in installations for carnivals, circuses, fairs, and similar events.	25	25	50
6	1910.307(b)	Hazardous (Classified) Locations—Documentation	50	80	80
1d	1910.308(b)(3)	Signs for emergency power systems	25	25	50
7	1910.308(e)(1)	Communication Systems—Protective Devices	10	30	40

Source: OSHA estimates, based on experience and knowledge of electrical practices.

TABLE 13.—DATA AND BASES FOR UNIT COSTS APPLIED IN OSHA'S FINAL COST ANALYSIS

Provision No.	Final rule	Labor costs [1]	Material costs
1	1910.303(f)(5), 1910.304(b)(1), 1910.306(c)(6), 1910.306(k)(4)(iv) and 1910.308(b)(3).	Average of 2 minutes of labor for each provision to install label at $28/hour ($20.44 × 1.37).	Average cost of label or sign: $2.
2	1910.303(h)(5)(iii)(B)	1 minute of labor to install label at $28/hour ($20.44 × 1.37).	Cost of label: $1.
3	1910.304(b)(3)(i)	None	GFCI: $5.
4	1910.304(b)(3)(ii)(A) and (b)(3)(ii)(B)	None	GFCI power station or cord: $55 each, annualized over 2-year useful life.
4a	(b)(3)(ii)(C) [2]	None	AEGC $110 (equivalent cost).
5	1910.306(j)(1)(iii)	3 hours at $28/hour ($20.44 × 1.37)	Various conduit, connectors, outlets: $75.

TABLE 13.—DATA AND BASES FOR UNIT COSTS APPLIED IN OSHA'S FINAL COST ANALYSIS—Continued

Provision No.	Final rule	Labor costs [1]	Material costs
6	1910.307(b)	4 hours at $28/hour ($20.44 × 1.37)	None.
7	1910.308(e)(1)	1 minute of labor to install label at $28/hour ($20.44 × 1.37).	Cost of label: $1.

[1] Note: The wage rate data are for 2000, taken from the BLS (2001) 2000 National Occupational Employment Statistics (OES) Survey. Fringe benefit rate data are from BLS (2000) Employer Costs for Employee Compensation, March. USDL: 00–186.
[2] Note: See the discussion of the methodology for estimating costs associated with the assured equipment grounding conductor program earlier in this section of the preamble.
Source: U.S. Dept. of Labor, OSHA, Office of Regulatory Analysis, 2006.

TABLE 14.—ANNUAL INCREMENTAL COMPLIANCE COSTS FOR CHANGES TO SUBPART S ELECTRICAL STANDARD

Provision No.	Final rule	Description of requirement	Annual costs for projects/establishments [1]			
			Total	Small	Medium	Large
1	1910.303(f)(5)	Marking for series combination ratings	$346,208	$221,365	$109,091	$15,751
2	1910.303(h)(5)(ii)(B)	Working Space and Guarding—Posting of Warning Signs.	66,839	49,141	16,145	1,554
1a	1910.304(b)(1)	Branch Circuits—Identification of Multiwire Branch Circuits.	Included in Provision 1.			
3	1910.304(b)(3)(i)	Ground-fault circuit interrupter protection for bathrooms and rooftops.	141,336	132,810	6,872	1,654
4	1910.304(b)(3)(ii)(A) and (b)(3)(ii)(B).	Ground-fault circuit interrupter protection for temporary wiring installations.	8,057,529	7,686,276	206,832	164,420
4a	1910.304(b)(3)(ii)(C)	Assured equipment grounding conductor program for temporary wiring installations.	5,332	0	3,600	1,733
1b	1910.306(c)(6)	Identification and signs for elevators, dumbwaiters, escalators, moving walks, wheelchair lifts, and stairway chair lifts.	Included in Provision 1.			
5	1910.306(j)(1)(iii)	Swimming Pools, Fountains, and Similar Installations—Receptacles.	36,050	31,865	3,422	763
1c	1910.306(k)(4)(iv)	Marking for single-pole portable cable connectors for parallel sets of conductors used in installations for carnivals, circuses, fairs, and similar events.	Included in Provision 1.			
6	1910.307(b)	Hazardous (Classified) Locations—Documentation.	846,930	756,479	77,816	12,635
1d	1910.308(b)(3)	Signs for emergency power systems	Included in Provision 1.			
7	1910.308(e)(1)	Communication Systems—Protective Devices	51,044	8,172	37,593	5,280
Total			9,550,457	8,886,108	460,716	203,633

[1] The total cost per establishment is estimated to be $12.36 for industries that handle flammable and/or combustible liquids, vapors, gases, dusts, and/or fibers and $10.44 for all other industries.
Source: U.S. Dept. of Labor, OSHA, Office of Regulatory Analysis, 2006.
Note: Compliance costs for all provisions except 4 are based on projects. Compliance costs for provision 4 are based on establishments (small establishments have 1–99 employees medium establishments have 100–499 employees, and large establishments have 500+ employees).

TABLE 15.—IMPACTS ON SMALL BUSINESSES

SIC [1]	Industry description	Number of small business establishments	Small business revenues ($1000)	Revenue per establishment	Profit rate (%)	Profit per establishment	Cost as a percent of revenue	Cost as a percent of profit
700	Agricultural services	109,663	$38,501,047	$351,085	6.02	$21,130	0.0029	0.0478
800	Forestry	2,400	1,496,747	623,645	10.30	64,235	0.0016	0.0157
900	Fishing, hunting, and trapping	NA	NA	NA	5.80	NA	NA	NA
1300	Oil And Gas Extraction	14,787	29,931,841	2,024,200	8.65	175,093	0.0006	0.0069
1500	General building contractors	195,315	234,203,450	1,199,106	4.00	47,964	0.0008	0.0211
1600	Heavy construction, except building	35,618	68,664,092	1,927,792	4.00	77,112	0.0005	0.0131
1700	Special trade contractors	426,477	270,401,924	634,036	4.00	25,361	0.0016	0.0398
2000	Food And Kindred Products	15,992	104,629,113	6,542,591	3.46	226,600	0.0002	0.0053

TABLE 15.—IMPACTS ON SMALL BUSINESSES—Continued

SIC [1]	Industry description	Number of small business establishments	Small business revenues ($1000)	Revenue per establishment	Profit rate (%)	Profit per establishment	Cost as a percent of revenue	Cost as a percent of profit
2100	Tobacco Products	91	1,255,255	13,794,011	4.02	554,130	0.0001	0.0022
2200	Textile Mill Products	4,845	20,377,246	4,205,830	2.77	116,423	0.0003	0.0103
2300	Apparel And Other Textile Products	22,383	38,507,048	1,720,370	2.56	44,010	0.0007	0.0273
2400	Lumber And Wood Products	35,076	58,343,756	1,663,353	3.90	64,854	0.0007	0.0185
2500	Furniture And Fixtures	11,217	26,295,821	2,344,283	3.51	82,285	0.0005	0.0146
2600	Paper And Allied Products	4,057	31,334,277	7,723,509	4.50	347,629	0.0002	0.0035
2700	Printing And Publishing	57,018	85,620,541	1,501,641	3.80	57,055	0.0008	0.0211
2800	Chemicals And Allied Products	8,227	59,010,014	7,172,726	4.49	321,776	0.0002	0.0037
2900	Petroleum And Coal Products	1,047	13,950,653	13,324,406	2.99	398,317	0.0001	0.0030
3000	Rubber And Misc. Plastics Products	13,043	58,709,872	4,501,255	4.02	181,167	0.0003	0.0066
3100	Leather And Leather Products	1,675	4,003,751	2,390,299	2.20	52,509	0.0005	0.0229
3200	Stone, Clay, And Glass Products	11,791	34,254,470	2,905,137	4.93	143,127	0.0004	0.0084
3300	Primary Metal Industries	4,806	36,511,582	7,597,083	4.52	343,213	0.0002	0.0035
3400	Fabricated Metal Products	34,250	113,752,781	3,321,249	4.55	150,988	0.0004	0.0080
3500	Industrial Machinery And Equipment	52,548	127,178,710	2,420,239	4.05	97,917	0.0005	0.0123
3600	Electronic & Other Electric Equipment.	14,355	69,499,940	4,841,514	5.59	270,705	0.0002	0.0044
3700	Transportation Equipment	10,653	41,544,504	3,899,794	3.74	145,974	0.0003	0.0082
3800	Instruments And Related Products ..	10,190	33,908,725	3,327,647	5.06	168,410	0.0004	0.0071
3900	Miscellaneous Manufacturing Industries.	17,837	30,627,905	1,717,100	3.80	65,322	0.0007	0.0184
4000	Railroad transportation	NA	NA	NA	11.08	NA	NA	NA
4100	Local and interurban passenger transit.	16,537	7,690,615	465,055	4.51	20,964	0.0022	0.0482
4200	Trucking And Warehousing	114,623	79,888,400	696,967	3.91	27,278	0.0017	0.0441
4400	Water Transportation	8,051	14,075,608	1,748,306	7.48	130,855	0.0007	0.0092
4500	Transportation by air	6,386	15,156,218	2,373,351	3.62	85,925	0.0004	0.0118
4600	Pipelines, Except Natural Gas	39	986,979	25,307,154	6.55	1,657,050	0.0000	0.0007
4700	Transportation Services	40,529	19,513,397	481,468	3.39	16,327	0.0025	0.0736
4800	Communications	17,482	41,125,079	2,352,424	5.58	131,244	0.0004	0.0077
4900	Electric, Gas, And Sanitary Services	8,938	10,824,146	1,211,026	10.37	125,641	0.0010	0.0096
5000	Wholesale Trade—Durable Goods ..	258,492	837,107,306	3,238,426	2.54	82,401	0.0004	0.0146
5100	Wholesale Trade—Nondurable Goods.	143,751	637,454,650	4,434,436	4.46	197,917	0.0003	0.0061
5200	Building Materials & Garden Supplies.	46,450	37,776,200	813,266	2.37	19,289	0.0015	0.0623
5300	General Merchandise Stores	8,796	3,346,901	380,503	2.70	10,283	0.0027	0.0982
5400	Food Stores	123,572	101,566,550	821,922	1.41	11,595	0.0012	0.0871
5500	Automotive Dealers & Service Stations.	116,015	149,337,410	1,287,225	1.45	18,609	0.0009	0.0646
5600	Apparel And Accessory Stores	50,308	18,706,435	371,838	1.85	6,867	0.0027	0.1471
5700	Home Furniture And Furnishings Stores.	78,842	45,392,798	575,744	2.28	13,142	0.0018	0.0768
5800	Eating And Drinking Places	355,297	128,561,814	361,843	3.00	10,850	0.0033	0.1108
5900	Miscellaneous Retail	258,538	119,265,615	461,308	2.49	11,479	0.0026	0.1047
6000	Depository Institutions	14,378	15,538,559	1,080,718	10.80	116,718	0.0009	0.0087
6100	Nondepository Institutions	21,262	13,454,697	632,805	15.05	95,230	0.0016	0.0106
6200	Security And Commodity Brokers	27,262	19,644,662	720,588	13.32	95,949	0.0014	0.0105
6300	Insurance Carriers	4,967	5,850,805	1,177,935	6.82	80,375	0.0009	0.0126
6400	Insurance Agents, Brokers, & Service.	119,907	47,083,678	392,668	6.83	26,800	0.0026	0.0377
6500	Real Estate	230,304	142,479,284	618,657	13.31	82,340	0.0016	0.0123
6700	Holding And Other Investment Offices.	21,022	35,174,755	1,673,235	24.01	401,733	0.0006	0.0025
7000	Hotels And Other Lodging Places	47,698	24,876,889	521,550	6.96	36,302	0.0019	0.0278
7200	Personal Services	176,477	36,957,629	209,419	5.86	12,262	0.0048	0.0824
7300	Business Services	337,126	188,061,601	557,838	4.79	26,703	0.0022	0.0450
7500	Auto Repair, Services, And Parking	167,057	66,003,052	395,093	4.39	17,356	0.0030	0.0692
7600	Miscellaneous Repair Services	63,328	25,861,556	408,375	5.44	22,198	0.0029	0.0541
7800	Motion Pictures	29,959	13,026,870	434,823	5.14	22,341	0.0023	0.0452
7900	Amusement & Recreation Services ..	90,742	47,922,810	528,122	4.28	22,604	0.0023	0.0532
8000	Health Services	413,561	243,370,668	588,476	6.17	36,312	0.0020	0.0331
8100	Legal Services	156,877	54,265,197	345,909	17.50	60,534	0.0029	0.0167
8200	Educational Services	40,592	25,677,552	632,577	8.14	51,502	0.0016	0.0196
8300	Social Services	117,544	50,553,841	430,084	4.44	19,088	0.0023	0.0529
8400	Museums, Botanical, Zoological Gardens.	4,912	2,928,264	596,145	21.45	127,873	0.0017	0.0079
8600	Membership Organizations	242,081	78,452,141	324,074	7.21	23,371	0.0031	0.0432

TABLE 15.—IMPACTS ON SMALL BUSINESSES—Continued

SIC [1]	Industry description	Number of small business establishments	Small business revenues ($1000)	Revenue per establishment	Profit rate (%)	Profit per establishment	Cost as a percent of revenue	Cost as a percent of profit
8700	Engineering and management services.	271,169	151,671,072	559,323	6.39	35,745	0.0018	0.0283
8900	Services, n.e.c	16,395	8,169,059	498,265	6.80	33,882	0.0020	0.0298

[1] Consistent with the preliminary analysis, OSHA in this final analysis has grouped affected industries according to the 1987 Standard Industrial Classification System. For industry coding under the North American Industry Classification System (NAICS), see NAICS, Executive Office of the President, Office of Management and Budget, 1997 and 2002.

Source: U.S. Dept. of Labor, OSHA, Office of Regulatory Analysis, 2006, based on U.S. Census Bureau, 2001, and Dun & Bradstreet, 2001.

VII. State Plan Standards

The 26 States or territories with OSHA-approved occupational safety and health plans must adopt an equivalent amendment or one that is at least as protective to employees within 6 months of the publication date of the final standard. These are: Alaska, Arizona, California, Connecticut (for State and local government employees only), Hawaii, Indiana, Iowa, Kentucky, Maryland, Michigan, Minnesota, Nevada, New Mexico, New Jersey (for State and local government employees only), New York (for State and local government employees only), North Carolina, Oregon, Puerto Rico, South Carolina, Tennessee, Utah, Vermont, Virginia, Virgin Islands, Washington, and Wyoming.

VIII. Environmental Impact Analysis

The final rule's provisions have been reviewed in accordance with the requirements of the National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. 4321, *et seq.*), the regulations of the Council on Environmental Quality (40 CFR Part 1502), and the Department of Labor's NEPA procedures (29 CFR Part 11). As a result of this review, OSHA has determined that these provisions will have no significant effect on air, water or soil quality, plant or animal life, on the use of land, or other aspects of the environment.

IX. Unfunded Mandates

This final rule has been reviewed in accordance with the Unfunded Mandates Reform Act of 1995 (UMRA) (2 U.S.C. 1501 *et seq.*). For the purposes of the UMRA, the Agency certifies that this final rule does not impose any Federal mandate that may result in increased expenditures by State, local, or tribal governments, or increased expenditures by the private sector, of more than $100 million in any year.

X. Federalism

OSHA has reviewed this rule in accordance with the Executive Order on Federalism (Executive Order 13132, 64 FR 43255, August 10, 1999), which requires that 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 there is clear constitutional authority and the presence of a problem of national scope. The Order provides for preemption of State law only if there is a clear Congressional intent for the Agency to do so. Any such preemption is to be limited to the extent possible.

Section 18 of the OSH Act expresses Congress's intent to preempt State laws where OSHA has promulgated occupational safety and health standards. A State can avoid preemption on issues covered by Federal standards only if it submits, and obtains Federal approval of, a plan for the development of such standards and their enforcement. 29 U.S.C. 667, *Gade* v. *National Solid Wastes Management Association,* 505 U.S. 88 (1992). Occupational safety and health standards developed by such Plan States must, among other things, be at least as effective in providing safe and healthful employment and places of employment as the Federal standards. Subject to the statutory limitations of the OSH Act, State-Plan States are free to develop and enforce their own requirements for occupational safety and health protections.

Although OSHA has a clear statutory mandate to preempt State occupational safety and health laws, States may enforce standards, such as State and local fire and building codes, which are designed to protect a wider class of persons than employees. As discussed earlier, the final rule introduces few new requirements that are not already mandated by applicable State and local law. In fact, most States and municipalities require compliance with the NEC, which is consistent with the final rule.

XI. OMB Review Under the Paperwork Reduction Act of 1995

The final rule Electrical Standard contains several collection-of-information (paperwork) requirements that are subject to review by the Office of Management and Budget (OMB) under the Paperwork Reduction Act of 1995 (PRA–95), 44 U.S.C. 3501 *et seq.,* and OMB's regulations at 5 CFR part 1320. PRA–95 defines ''collection of information'' as ''the obtaining, causing to be obtained, soliciting, or requiring the disclosure to third parties or the public of facts or opinions by or for an agency regardless of form or format * * *'' (44 U.S.C. 3502(3)(A)). The collection-of-information requirements contained in the proposed Design Safety Standards for Electrical Systems was submitted to OMB on April 2, 2004. On December 7, 2004, OMB provided the following comment regarding its review of the paperwork requirements contained in the proposed rule:

> The information collection provisions associated with the Design Safety Standards for Electrical Systems proposed rule are not approved at this time. OSHA will examine public comment in response to the [Notice of Proposed Rulemaking] and will describe in the preamble of the final rule how the [A]gency has maximized the practical utility of the collection and minimized its burden.

In the preamble to the proposed rule, OSHA asked for comments on each of the paperwork requirements in the Electrical Standard for general industry, Subpart S. OSHA received no comments on the paperwork burdens or OSHA's estimation of those burdens. However, OSHA added a provision to the standard based on comments received on the proposed GFCI requirements. In response to those comments, the Agency added a requirement for the assured equipment grounding conductor program under limited conditions. This new provision will add 203 hours to the paperwork burden.

The collection-of-information requirements contained in the final rule also include requirements in § 1910.303 for marking series combination ratings, § 1910.304—Wiring design and protection, § 1910.306—Specific purpose equipment and installations, § 1910.307—Hazardous (classified) locations, and § 1910.308—Special systems. The final Information-Collection Request estimates the total burden hours associated with the collection-of-information requirements to be approximately 9,353 hours and estimates the cost for maintenance and operation to be approximately $3,750. OMB is currently reviewing OSHA's request for approval of the collection-of-information requirements in the final rule.

These collection-of-information requirements are needed to provide electrical safety to employees against the electric shock hazards that might be present in the workplace. The marking of electric equipment with proper ratings, identifying the phase and system of each ungrounded conductor, labeling certain disconnecting means with indentification signs, using the assured equipment grounding conductor program whenever approved GFCIs are not available, and documenting hazardous classified areas are all ways of reducing the electrical hazards posed on employees. OSHA will use the records developed in response to this standard to determine compliance. The employer's failure to generate and disclose the information required in this standard will affect significantly OSHA's effort to control and reduce injuries and fatalities related to electrical hazards in the workplace.

OSHA minimized the burden hours imposed by collections of information contained in the standard by relying heavily on the National Electrical Code and NFPA 70E, Standard for Electrical Safety Requirements for Employee Workplaces. The collections of information in the standard mirror current industry practice and, therefore, impose minimal burden on employers and eliminate any confusion between current industry practice and the standard. The Agency believes that the information-collection frequencies required by the standard are the minimum frequencies necessary to effectively regulate the electrical hazards posed by the workforce.

Potential respondents are not required to respond to the information collection requirements until they have been approved and a currently valid OMB control number is displayed. OMB is currently reviewing OSHA's request for approval of the 29 CFR Part 1910 Subpart S information collections. OSHA will publish a subsequent **Federal Register** document when OMB takes further action on the information collection requirements in the Electrical Standards rule.

XII. Effective Date and Date of Application

The scope and application of Subpart S is set forth in § 1910.302 in paragraphs (b)(1) through (b)(4). The paragraphs are as follows: (b)(1) all installations regardless of when the installation was built; (b)(2) all installations built after March 15, 1972; (b)(3) all installations built after April 16, 1981; and (b)(4) all installations built after the final rule is published.

In the preamble to the Proposal, OSHA proposed to make some new requirements effective 90 days after the final rule is published. We invited comments on whether this time is sufficient to implement the changes required by the revised standard.

International Paper stated that companies will need at least 90 days to effectively communicate and implement the provisions in the standard, even within a large organization (Ex. 3–6). They further stated that this period would allow companies to develop and update site specific electrical safety programs and would allow large companies to develop policies supplemental to the OSHA standards as well as adequately address site issues and concerns. In addition, they noted that the current electrical design and installation would need to be reviewed for compliance. They stated that the proposed changes to the depth of working space in front of electrical equipment, and proposed changes to elevation requirements to unguarded live parts of electrical equipment, for example, may necessitate design or construction changes.

Two commenters did not believe that 90 days after the final rule is published would be enough time for employers to effectively implement the new requirements proposed in the electrical standard, especially in states not mandating the latest codes (Exs. 3–3, 3–10). These commenters recommended that the effective date be 180 days after the final rule is published. One of these commenters, Duke Energy Corporation, argued that additional time would be needed for employers to determine compliance and then retrofit installations if necessary. The other commenter, ORC World Wide, said that employers need to determine how the new requirements apply to their installations and plan accordingly. They argued that the standard is complex and may take companies time to understand and assimilate the standard into their operations.

OSHA agrees with the public comments on the effective date and recognizes that companies may need additional time to implement the standard. For the reasons given by these commenters, the Agency will grant the request to extend the effective date to 180 days after the final rule is published.

Accordingly, the effective date of this final rule is 180 days after publication. The 180-day period between the issuance of the standard and their effective date is intended to provide sufficient time for employers and employees to become informed of and comply with the requirements of the standard.

The standards currently found in the existing Subpart S (§§ 1910.302 through 1910.308) remain in effect until the standards contained in this rule actually go into effect. Should the new standards be stayed, judicially or administratively, or should the standards not sustain legal challenge under section 6(f) of the OSH Act, the existing standards in Subpart S will remain in effect.

Any petitions for administrative reconsiderations of these standards or for an administrative stay pending judicial review must be filed with the Assistant Secretary of Labor for Occupational Safety and Health on or before April 16, 2007. Any petitions filed after this day will be considered to be filed untimely.

As discussed fully in the summary and explanation of final § 1910.302(b), in section V. earlier in this preamble, OSHA is making the new requirements in revised Subpart S effective 180 days after the final rule is published in the **Federal Register.** It should be noted that applying new provisions only to new installations is the same approach that OSHA took in promulgating the current version of Subpart S in 1981. The Agency found that this approach was successful and has no indication that it was unduly burdensome or insufficiently protective.

List of Subjects in 29 CFR Part 1910

Electric power, Fire prevention, Hazardous substances, Occupational safety and health, Safety.

Authority and Signature

This document was prepared under the direction of Edwin G. Foulke, Jr., Assistant Secretary of Labor for Occupational Safety and Health, 200 Constitution Avenue, NW., Washington, DC 20210.

This action is taken pursuant to sections 4, 6, and 8 of the Occupational Safety and Health Act of 1970 (29 U.S.C. 653, 655, 657), Secretary of Labor's Order No. 5–2002 (67 F.R. 65008), and 29 CFR Part 1911.

Signed at Washington, DC, this 24th day of January, 2007.

Edwin G. Foulke, Jr.,

Assistant Secretary of Labor.

PART 1910—[AMENDED]

■ Part 1910 of Title 29 of the Code of Federal Regulations is amended as follows:

Subpart A—General

■ 1. The authority citation for Subpart A is revised to read as follows:

Authority: Sections 4, 6, and 8 of the Occupational Safety and Health Act of 1970 (29 U.S.C. 653, 655, and 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), or 5–2002 (67 FR 65008), as applicable.

Sections 1910.6, 1910.7, and 1910.8 also issued under 29 CFR part 1911. Section 1910.7(f) also issued under 31 U.S.C. 9701, 29 U.S.C. 9 a, 5 U.S.C. 553; Public Law 106–113 (113 Stat. 1501A–222); and OMB Circular A–25 (dated July 8, 1993) (58 FR 38142, July 15, 1993).

■ 2. Section 1910.6 is amended by revising the introductory text to paragraph (e), removing and reserving paragraph (e)(33), revising the introductory text to paragraph (q), and removing and reserving paragraph (q)(16). The revised text reads as follows:

§ 1910.6 Incorporation by reference.

* * * * *

(e) The following material is available for purchase from the American National Standards Institute (ANSI), 25 West 43rd Street, Fourth Floor, New York, NY 10036:

* * * * *

(q) The following material is available for purchase from the National Fire Protection Association (NFPA), 1 Batterymarch Park, Quincy, MA 02269:

* * * * *

Subpart F—Powered Platforms, Manlifts, and Vehicle-Mounted Work Platforms

■ 3. The authority citation for Subpart F is revised to read as follows:

Authority: Secs. 4, 6, and 8 of the Occupational Safety and Health Act of 1970 (29 U.S.C. 653, 655, and 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), or 5–2002 (67 FR 65008), as applicable; and 29 CFR part 1911.

■ 4. Appendix D to § 1910.66 is amended as follows:

■ a. Paragraph (c)(22)(i) is revised as set forth below.

■ b. In the second sentence of paragraph (c)(22)(vii), the words ''Article 610 of the National Electrical Code, NFPA 70–1971; ANSI C1–1971 (Rev. of C1–1968)'' are revised to read ''Subpart S of this Part.''

§ 1910.66 Powered platforms for building maintenance.

* * * * *

Appendix D to § 1910.66—Existing Installations (Mandatory)

* * * * *

(c) * * *

(22) * * * (i) All electrical equipment and wiring shall conform to the requirements of Subpart S of this Part, except as modified by ANSI A120.1—1970 ''American National Standard Safety Requirements for Powered Platforms for Exterior Building Maintenance'' (see § 1910.6). For detail design specifications for electrical equipment, see Part 2, ANSI A120.1–1970.

* * * * *

Subpart S—Electrical

■ 5. The authority citation for Subpart S is revised to read as follows:

Authority: Secs. 4, 6, 8, Occupational Safety and Health Act of 1970 (29 U.S.C. 653, 655, 657); Secretary of Labor's Order No. 8–76 (41 FR 25059), 1–90 (55 FR 9033), or 5–2002 (67 F.R. 65008), as applicable; 29 CFR Part 1911.

■ 6. Sections 1910.302 through 1910.308 are revised to read as follows:

Design Safety Standards for Electrical Systems

§ 1910.302 Electric utilization systems.

Sections 1910.302 through 1910.308 contain design safety standards for electric utilization systems.

(a) *Scope*—(1) *Covered.* The provisions of §§ 1910.302 through 1910.308 cover electrical installations and utilization equipment installed or used within or on buildings, structures, and other premises, including:

(i) Yards;

(ii) Carnivals;

(iii) Parking and other lots;

(iv) Mobile homes;

(v) Recreational vehicles;

(vi) Industrial substations;

(vii) Conductors that connect the installations to a supply of electricity; and

(viii) Other outside conductors on the premises.

(2) *Not covered.* The provisions of §§ 1910.302 through 1910.308 do not cover:

(i) Installations in ships, watercraft, railway rolling stock, aircraft, or automotive vehicles other than mobile homes and recreational vehicles;

(ii) Installations underground in mines;

(iii) Installations of railways for generation, transformation, transmission, or distribution of power used exclusively for operation of rolling stock or installations used exclusively for signaling and communication purposes;

(iv) Installations of communication equipment under the exclusive control of communication utilities, located outdoors or in building spaces used exclusively for such installations; or

(v) Installations under the exclusive control of electric utilities for the purpose of communication or metering; or for the generation, control, transformation, transmission, and distribution of electric energy located in buildings used exclusively by utilities for such purposes or located outdoors on property owned or leased by the utility or on public highways, streets, roads, etc., or outdoors by established rights on private property.

(b) *Extent of application*—(1) *Requirements applicable to all installations.* The following requirements apply to all electrical installations and utilization equipment, regardless of when they were designed or installed:

§ 1910.303(b)—Examination, installation, and use of equipment

§ 1910.303(c)(3)—Electrical connections—Splices

§ 1910.303(d)—Arcing parts

§ 1910.303(e)—Marking

§ 1910.303(f), except (f)(4) and (f)(5)—Disconnecting means and circuits

§ 1910.303(g)(2)—600 volts or less—Guarding of live parts

§ 1910.304(a)(3)—Use of grounding terminals and devices

§ 1910.304(f)(1)(i), (f)(1)(iv), and (f)(1)(v)—Overcurrent protection—600 volts, nominal, or less

§ 1910.304(g)(1)(ii), (g)(1)(iii), (g)(1)(iv), and (g)(1)(v)—Grounding—Systems to be grounded

§ 1910.304(g)(4)—Grounding—Grounding connections

§ 1910.304(g)(5)—Grounding—Grounding path

§ 1910.304(g)(6)(iv)(A) through (g)(6)(iv)(D), and (g)(6)(vi)—Grounding—Supports, enclosures, and equipment to be grounded

§ 1910.304(g)(7)—Grounding—Nonelectrical equipment

§ 1910.304(g)(8)(i)—Grounding—Methods of grounding fixed equipment
§ 1910.305(g)(1)—Flexible cords and cables—Use of flexible cords and cables
§ 1910.305(g)(2)(ii) and (g)(2)(iii)—Flexible cords and cables—Identification, splices, and terminations
§ 1910.307, except as specified in § 1910.307(b)—Hazardous (classified) locations

(2) *Requirements applicable to installations made after March 15, 1972.* Every electrical installation and all utilization equipment installed or overhauled after March 15, 1972, shall comply with the provisions of §§ 1910.302 through 1910.308, except as noted in paragraphs (b)(3) and (b)(4) of this section.

(3) *Requirements applicable only to installations made after April 16, 1981.* The following requirements apply only to electrical installations and utilization equipment installed after April 16, 1981:

§ 1910.303(h)(4)—Over 600 volts, nominal—Entrance and access to work space
§ 1910.304(f)(1)(vii) and (f)(1)(viii)—Overcurrent protection—600 volts, nominal, or less
§ 1910.304(g)(9)(i)—Grounding—Grounding of systems and circuits of 1000 volts and over (high voltage)
§ 1910.305(j)(6)(ii)(D)—Equipment for general use—Capacitors
§ 1910.306(c)(9)—Elevators, dumbwaiters, escalators, moving walks, wheelchair lifts, and stairway chair lifts—Interconnection between multicar controllers
§ 1910.306(i)—Electrically driven or controlled irrigation machines
§ 1910.306(j)(5)—Swimming pools, fountains, and similar installations—Fountains
§ 1910.308(a)(1)(ii)—Systems over 600 volts, nominal—Aboveground wiring methods
§ 1910.308(c)(2)—Class 1, Class 2, and Class 3 remote control, signaling, and power-limited circuits—Marking
§ 1910.308(d)—Fire alarm systems

(4) *Requirements applicable only to installations made after August 13, 2007.* The following requirements apply only to electrical installations and utilization equipment installed after August 13, 2007:

§ 1910.303(f)(4)—Disconnecting means and circuits—Capable of accepting a lock
§ 1910.303(f)(5)—Disconnecting means and circuits—Marking for series combination ratings
§ 1910.303(g)(1)(iv) and (g)(1)(vii)—600 Volts, nominal, or less—Space about electric equipment
§ 1910.303(h)(5)(vi)—Over 600 volts, nominal—Working space and guarding
§ 1910.304(b)(1)—Branch circuits—Identification of multiwire branch circuits
§ 1910.304(b)(3)(i)—Branch circuits—Ground-fault circuit interrupter protection for personnel
§ 1910.304(f)(2)(i)(A), (f)(2)(i)(B) (but not the introductory text to § 1910.304(f)(2)(i)), and (f)(2)(iv)(A)—Overcurrent protection—Feeders and branch circuits over 600 volts, nominal
§ 1910.305(c)(3)(ii)—Switches—Connection of switches
§ 1910.305(c)(5)—Switches—Grounding
§ 1910.306(a)(1)(ii)—Electric signs and outline lighting—Disconnecting means
§ 1910.306(c)(4)—Elevators, dumbwaiters, escalators, moving walks, wheelchair lifts, and stairway chair lifts—Operation
§ 1910.306(c)(5)—Elevators, dumbwaiters, escalators, moving walks, wheelchair lifts, and stairway chair lifts—Location
§ 1910.306(c)(6)—Elevators, dumbwaiters, escalators, moving walks, wheelchair lifts, and stairway chair lifts—Identification and signs
§ 1910.306(c)(7)—Elevators, dumbwaiters, escalators, moving walks, wheelchair lifts, and stairway chair lifts—Single-car and multicar installations
§ 1910.306(j)(1)(iii)—Swimming pools, fountains, and similar installations—Receptacles
§ 1910.306(k)—Carnivals, circuses, fairs, and similar events
§ 1910.308(a)(5)(v) and (a)(5)(vi)(B)—Systems over 600 volts, nominal—Interrupting and isolating devices
§ 1910.308(a)(7)(vi)—Systems over 600 volts, nominal—Tunnel installations
§ 1910.308(b)(3)—Emergency power systems—Signs
§ 1910.308(c)(3)—Class 1, Class 2, and Class 3 remote control, signaling, and power-limited circuits—Separation from conductors of other circuits
§ 1910.308(f)—Solar photovoltaic systems

(c) *Applicability of requirements for disconnecting means.* The requirement in § 1910.147(c)(2)(iii) that energy isolating devices be capable of accepting a lockout device whenever replacement or major repair, renovation or modification of a machine or equipment is performed, and whenever new machines or equipment are installed after January 2, 1990, applies in addition to any requirements in § 1910.303 through § 1910.308 that disconnecting means be capable of being locked in the open position under certain conditions.

§ 1910.303 General.

(a) *Approval.* The conductors and equipment required or permitted by this subpart shall be acceptable only if approved, as defined in § 1910.399.

(b) *Examination, installation, and use of equipment*—(1) *Examination.* Electric equipment shall be free from recognized hazards that are likely to cause death or serious physical harm to employees. Safety of equipment shall be determined using the following considerations:

(i) Suitability for installation and use in conformity with the provisions of this subpart;

Note to paragraph (b)(1)(i) of this section: Suitability of equipment for an identified purpose may be evidenced by listing or labeling for that identified purpose.

(ii) Mechanical strength and durability, including, for parts designed to enclose and protect other equipment, the adequacy of the protection thus provided;

(iii) Wire-bending and connection space;

(iv) Electrical insulation;

(v) Heating effects under all conditions of use;

(vi) Arcing effects;

(vii) Classification by type, size, voltage, current capacity, and specific use; and

(viii) Other factors that contribute to the practical safeguarding of persons using or likely to come in contact with the equipment.

(2) *Installation and use.* Listed or labeled equipment shall be installed and used in accordance with any instructions included in the listing or labeling.

(3) *Insulation integrity.* Completed wiring installations shall be free from short circuits and from grounds other than those required or permitted by this subpart.

(4) *Interrupting rating.* Equipment intended to interrupt current at fault levels shall have an interrupting rating sufficient for the nominal circuit voltage and the current that is available at the line terminals of the equipment. Equipment intended to interrupt current at other than fault levels shall have an interrupting rating at nominal circuit voltage sufficient for the current that must be interrupted.

(5) *Circuit impedance and other characteristics.* The overcurrent protective devices, the total impedance,

the component short-circuit current ratings, and other characteristics of the circuit to be protected shall be selected and coordinated to permit the circuit protective devices used to clear a fault to do so without the occurrence of extensive damage to the electrical components of the circuit. This fault shall be assumed to be either between two or more of the circuit conductors, or between any circuit conductor and the grounding conductor or enclosing metal raceway.

(6) *Deteriorating agents.* Unless identified for use in the operating environment, no conductors or equipment shall be located in damp or wet locations; where exposed to gases, fumes, vapors, liquids, or other agents that have a deteriorating effect on the conductors or equipment; or where exposed to excessive temperatures.

(7) *Mechanical execution of work.* Electric equipment shall be installed in a neat and workmanlike manner.

(i) Unused openings in boxes, raceways, auxiliary gutters, cabinets, equipment cases, or housings shall be effectively closed to afford protection substantially equivalent to the wall of the equipment.

(ii) Conductors shall be racked to provide ready and safe access in underground and subsurface enclosures that persons enter for installation and maintenance.

(iii) Internal parts of electrical equipment, including busbars, wiring terminals, insulators, and other surfaces, may not be damaged or contaminated by foreign materials such as paint, plaster, cleaners, abrasives, or corrosive residues.

(iv) There shall be no damaged parts that may adversely affect safe operation or mechanical strength of the equipment, such as parts that are broken, bent, cut, or deteriorated by corrosion, chemical action, or overheating.

(8) *Mounting and cooling of equipment.* (i) Electric equipment shall be firmly secured to the surface on which it is mounted.

Note to paragraph (b)(8)(i) of this section: Wooden plugs driven into holes in masonry, concrete, plaster, or similar materials are not considered secure means of fastening electric equipment.

(ii) Electric equipment that depends on the natural circulation of air and convection principles for cooling of exposed surfaces shall be installed so that room airflow over such surfaces is not prevented by walls or by adjacent installed equipment. For equipment designed for floor mounting, clearance between top surfaces and adjacent surfaces shall be provided to dissipate rising warm air.

(iii) Electric equipment provided with ventilating openings shall be installed so that walls or other obstructions do not prevent the free circulation of air through the equipment.

(c) *Electrical connections*—(1) *General.* Because of different characteristics of dissimilar metals:

(i) Devices such as pressure terminal or pressure splicing connectors and soldering lugs shall be identified for the material of the conductor and shall be properly installed and used;

(ii) Conductors of dissimilar metals may not be intermixed in a terminal or splicing connector where physical contact occurs between dissimilar conductors (such as copper and aluminum, copper and copper-clad aluminum, or aluminum and copper-clad aluminum) unless the device is identified for the purpose and conditions of use; and

(iii) Materials such as solder, fluxes, inhibitors, and compounds, where employed, shall be suitable for the use and shall be of a type that will not adversely affect the conductors, installation, or equipment.

(2) *Terminals.* (i) Connection of conductors to terminal parts shall ensure a good connection without damaging the conductors and shall be made by means of pressure connectors (including set-screw type), solder lugs, or splices to flexible leads. However, No. 10 or smaller conductors may be connected by means of wire binding screws or studs and nuts having upturned lugs or equivalent.

(ii) Terminals for more than one conductor and terminals used to connect aluminum shall be so identified.

(3) *Splices.* (i) Conductors shall be spliced or joined with splicing devices identified for the use or by brazing, welding, or soldering with a fusible metal or alloy. Soldered splices shall first be spliced or joined to be mechanically and electrically secure without solder and then soldered. All splices and joints and the free ends of conductors shall be covered with an insulation equivalent to that of the conductors or with an insulating device identified for the purpose.

(ii) Wire connectors or splicing means installed on conductors for direct burial shall be listed for such use.

(d) *Arcing parts.* Parts of electric equipment that in ordinary operation produce arcs, sparks, flames, or molten metal shall be enclosed or separated and isolated from all combustible material.

(e) *Marking*—(1) *Identification of manufacturer and ratings.* Electric equipment may not be used unless the following markings have been placed on the equipment:

(i) The manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the product may be identified; and

(ii) Other markings giving voltage, current, wattage, or other ratings as necessary.

(2) *Durability.* The marking shall be of sufficient durability to withstand the environment involved.

(f) *Disconnecting means and circuits*—(1) *Motors and appliances.* Each disconnecting means required by this subpart for motors and appliances shall be legibly marked to indicate its purpose, unless located and arranged so the purpose is evident.

(2) *Services, feeders, and branch circuits.* Each service, feeder, and branch circuit, at its disconnecting means or overcurrent device, shall be legibly marked to indicate its purpose, unless located and arranged so the purpose is evident.

(3) *Durability of markings.* The markings required by paragraphs (f)(1) and (f)(2) of this section shall be of sufficient durability to withstand the environment involved.

(4) *Capable of accepting a lock.* Disconnecting means required by this subpart shall be capable of being locked in the open position.

(5) *Marking for series combination ratings.* (i) Where circuit breakers or fuses are applied in compliance with the series combination ratings marked on the equipment by the manufacturer, the equipment enclosures shall be legibly marked in the field to indicate that the equipment has been applied with a series combination rating.

(ii) The marking required by paragraph (f)(5)(i) of this section shall be readily visible and shall state ''Caution—Series Combination System Rated ____ Amperes. Identified Replacement Component Required.''

(g) *600 Volts, nominal, or less.* This paragraph applies to electric equipment operating at 600 volts, nominal, or less to ground.

(1) *Space about electric equipment.* Sufficient access and working space shall be provided and maintained about all electric equipment to permit ready and safe operation and maintenance of such equipment.

(i) Working space for equipment likely to require examination, adjustment, servicing, or maintenance while energized shall comply with the following dimensions, except as required or permitted elsewhere in this subpart:

(A) The depth of the working space in the direction of access to live parts may not be less than indicated in Table S–1. Distances shall be measured from the live parts if they are exposed or from the enclosure front or opening if they are enclosed;

(B) The width of working space in front of the electric equipment shall be the width of the equipment or 762 mm (30 in.), whichever is greater. In all cases, the working space shall permit at least a 90-degree opening of equipment doors or hinged panels; and

(C) The work space shall be clear and extend from the grade, floor, or platform to the height required by paragraph (g)(1)(vi) of this section. However, other equipment associated with the electrical installation and located above or below the electric equipment may extend not more than 153 mm (6 in.) beyond the front of the electric equipment.

(ii) Working space required by this standard may not be used for storage. When normally enclosed live parts are exposed for inspection or servicing, the working space, if in a passageway or general open space, shall be suitably guarded.

(iii) At least one entrance of sufficient area shall be provided to give access to the working space about electric equipment.

(iv) For equipment rated 1200 amperes or more and over 1.83 m (6.0 ft) wide, containing overcurrent devices, switching devices, or control devices, there shall be one entrance not less than 610 mm (24 in.) wide and 1.98 m (6.5 ft) high at each end of the working space, except that:

(A) Where the location permits a continuous and unobstructed way of exit travel, one means of exit is permitted; or

(B) Where the working space required by paragraph (g)(1)(i) of this section is doubled, only one entrance to the working space is required; however, the entrance shall be located so that the edge of the entrance nearest the equipment is the minimum clear distance given in Table S–1 away from such equipment.

(v) Illumination shall be provided for all working spaces about service equipment, switchboards, panelboards, and motor control centers installed indoors. Additional lighting fixtures are not required where the working space is illuminated by an adjacent light source. In electric equipment rooms, the illumination may not be controlled by automatic means only.

(vi) The minimum headroom of working spaces about service equipment, switchboards, panelboards, or motor control centers shall be as follows:

(A) For installations built before August 13, 2007, 1.91 m (6.25 ft); and

(B) For installations built on or after August 13, 2007, 1.98 m (6.5 ft), except that where the electrical equipment exceeds 1.98 m (6.5 ft) in height, the minimum headroom may not be less than the height of the equipment.

TABLE S–1.—MINIMUM DEPTH OF CLEAR WORKING SPACE AT ELECTRIC EQUIPMENT, 600 V OR LESS

Nominal voltage to ground	Minimum clear distance for condition [2 3]					
	Condition A		Condition B		Condition C	
	m	ft	m	ft	m	ft
0–150	[1]0.9	[1]3.0	[1]0.9	[1]3.0	0.9	3.0
151–600	[1]0.9	[1]3.0	1.0	3.5	1.2	4.0

Notes to Table S–1:

1. Minimum clear distances may be 0.7 m (2.5 ft) for installations built before April 16, 1981.

2. Conditions A, B, and C are as follows:

Condition A—Exposed live parts on one side and no live or grounded parts on the other side of the working space, or exposed live parts on both sides effectively guarded by suitable wood or other insulating material. Insulated wire or insulated busbars operating at not over 300 volts are not considered live parts.

Condition B—Exposed live parts on one side and grounded parts on the other side.

Condition C—Exposed live parts on both sides of the work space (not guarded as provided in Condition A) with the operator between.

3. Working space is not required in back of assemblies such as dead-front switchboards or motor control centers where there are no renewable or adjustable parts (such as fuses or switches) on the back and where all connections are accessible from locations other than the back. Where rear access is required to work on deenergized parts on the back of enclosed equipment, a minimum working space of 762 mm (30 in.) horizontally shall be provided.

(vii) Switchboards, panelboards, and distribution boards installed for the control of light and power circuits, and motor control centers shall be located in dedicated spaces and protected from damage.

(A) For indoor installation, the dedicated space shall comply with the following:

(1) The space equal to the width and depth of the equipment and extending from the floor to a height of 1.83 m (6.0 ft) above the equipment or to the structural ceiling, whichever is lower, shall be dedicated to the electrical installation. Unless isolated from equipment by height or physical enclosures or covers that will afford adequate mechanical protection from vehicular traffic or accidental contact by unauthorized personnel or that complies with paragraph (g)(1)(vii)(A)(2) of this section, piping, ducts, or equipment foreign to the electrical installation may not be located in this area;

(2) The space equal to the width and depth of the equipment shall be kept clear of foreign systems unless protection is provided to avoid damage from condensation, leaks, or breaks in such foreign systems. This area shall extend from the top of the electric equipment to the structural ceiling;

(3) Sprinkler protection is permitted for the dedicated space where the piping complies with this section; and

(4) Control equipment that by its very nature or because of other requirements in this subpart must be adjacent to or within sight of its operating machinery is permitted in the dedicated space.

Note to paragraph (g)(1)(vii)(A) of this section: A dropped, suspended, or similar ceiling that does not add strength to the building structure is not considered a structural ceiling.

(B) Outdoor electric equipment shall be installed in suitable enclosures and shall be protected from accidental contact by unauthorized personnel, or by vehicular traffic, or by accidental spillage or leakage from piping systems. No architectural appurtenance or other equipment may be located in the working space required by paragraph (g)(1)(i) of this section.

(2) *Guarding of live parts.* (i) Except as elsewhere required or permitted by this standard, live parts of electric equipment operating at 50 volts or more shall be guarded against accidental

contact by use of approved cabinets or other forms of approved enclosures or by any of the following means:

(A) By location in a room, vault, or similar enclosure that is accessible only to qualified persons;

(B) By suitable permanent, substantial partitions or screens so arranged so that only qualified persons will have access to the space within reach of the live parts. Any openings in such partitions or screens shall be so sized and located that persons are not likely to come into accidental contact with the live parts or to bring conducting objects into contact with them;

(C) By placement on a suitable balcony, gallery, or platform so elevated and otherwise located as to prevent access by unqualified persons; or

(D) By elevation of 2.44 m (8.0 ft) or more above the floor or other working surface.

(ii) In locations where electric equipment is likely to be exposed to physical damage, enclosures or guards shall be so arranged and of such strength as to prevent such damage.

(iii) Entrances to rooms and other guarded locations containing exposed live parts shall be marked with conspicuous warning signs forbidding unqualified persons to enter.

(h) *Over 600 volts, nominal*—(1) *General.* Conductors and equipment used on circuits exceeding 600 volts, nominal, shall comply with all applicable provisions of the paragraphs (a) through (g) of this section and with the following provisions, which supplement or modify the preceding requirements. However, paragraphs (h)(2), (h)(3), and (h)(4) of this section do not apply to the equipment on the supply side of the service point.

(2) *Enclosure for electrical installations.* (i) Electrical installations in a vault, room, or closet or in an area surrounded by a wall, screen, or fence, access to which is controlled by lock and key or other approved means, are considered to be accessible to qualified persons only. The type of enclosure used in a given case shall be designed and constructed according to the hazards associated with the installation.

(ii) For installations other than equipment described in paragraph (h)(2)(v) of this section, a wall, screen, or fence shall be used to enclose an outdoor electrical installation to deter access by persons who are not qualified. A fence may not be less than 2.13 m (7.0 ft) in height or a combination of 1.80 m (6.0 ft) or more of fence fabric and a 305-mm (1-ft) or more extension utilizing three or more strands of barbed wire or equivalent.

(iii) The following requirements apply to indoor installations that are accessible to other than qualified persons:

(A) The installations shall be made with metal-enclosed equipment or shall be enclosed in a vault or in an area to which access is controlled by a lock;

(B) Metal-enclosed switchgear, unit substations, transformers, pull boxes, connection boxes, and other similar associated equipment shall be marked with appropriate caution signs; and

(C) Openings in ventilated dry-type transformers and similar openings in other equipment shall be designed so that foreign objects inserted through these openings will be deflected from energized parts.

(iv) Outdoor electrical installations having exposed live parts shall be accessible to qualified persons only.

(v) The following requirements apply to outdoor enclosed equipment accessible to unqualified employees:

(A) Ventilating or similar openings in equipment shall be so designed that foreign objects inserted through these openings will be deflected from energized parts;

(B) Where exposed to physical damage from vehicular traffic, suitable guards shall be provided;

(C) Nonmetallic or metal-enclosed equipment located outdoors and accessible to the general public shall be designed so that exposed nuts or bolts cannot be readily removed, permitting access to live parts;

(D) Where nonmetallic or metal-enclosed equipment is accessible to the general public and the bottom of the enclosure is less than 2.44 m (8.0 ft) above the floor or grade level, the enclosure door or hinged cover shall be kept locked; and

(E) Except for underground box covers that weigh over 45.4 kg (100 lb), doors and covers of enclosures used solely as pull boxes, splice boxes, or junction boxes shall be locked, bolted, or screwed on.

(3) *Work space about equipment.* Sufficient space shall be provided and maintained about electric equipment to permit ready and safe operation and maintenance of such equipment. Where energized parts are exposed, the minimum clear work space may not be less than 1.98 m (6.5 ft) high (measured vertically from the floor or platform) or less than 914 mm (3.0 ft) wide (measured parallel to the equipment). The depth shall be as required in paragraph (h)(5)(i) of this section. In all cases, the work space shall be adequate to permit at least a 90-degree opening of doors or hinged panels.

(4) *Entrance and access to work space.* (i) At least one entrance not less than 610 mm (24 in.) wide and 1.98 m (6.5 ft) high shall be provided to give access to the working space about electric equipment.

(A) On switchboard and control panels exceeding 1.83 m (6.0 ft) in width, there shall be one entrance at each end of such boards unless the location of the switchboards and control panels permits a continuous and unobstructed way of exit travel, or unless the work space required in paragraph (h)(5)(i) of this section is doubled.

(B) Where one entrance to the working space is permitted under the conditions described in paragraph (h)(4)(i)(A) of this section, the entrance shall be located so that the edge of the entrance nearest the switchboards and control panels is at least the minimum clear distance given in Table S–2 away from such equipment.

(C) Where bare energized parts at any voltage or insulated energized parts above 600 volts, nominal, to ground are located adjacent to such entrance, they shall be suitably guarded.

(ii) Permanent ladders or stairways shall be provided to give safe access to the working space around electric equipment installed on platforms, balconies, mezzanine floors, or in attic or roof rooms or spaces.

(5) *Working space and guarding.* (i)(vi) Except as elsewhere required or permitted in this subpart, the minimum clear working space in the direction of access to live parts of electric equipment may not be less than specified in Table S–2. Distances shall be measured from the live parts, if they are exposed, or from the enclosure front or opening, if they are enclosed.

(ii) If switches, cutouts, or other equipment operating at 600 volts, nominal, or less, are installed in a room or enclosure where there are exposed live parts or exposed wiring operating at over 600 volts, nominal, the high-voltage equipment shall be effectively separated from the space occupied by the low-voltage equipment by a suitable partition, fence, or screen. However, switches or other equipment operating at 600 volts, nominal, or less, and serving only equipment within the high-voltage vault, room, or enclosure may be installed in the high-voltage enclosure, room, or vault if accessible to qualified persons only.

(iii) The following requirements apply to the entrances to all buildings, rooms, or enclosures containing exposed live parts or exposed conductors operating at over 600 volts, nominal:

(A) The entrances shall be kept locked unless they are under the observation of a qualified person at all times; and

(B) Permanent and conspicuous warning signs shall be provided, reading substantially as follows:

''DANGER—HIGH VOLTAGE—KEEP OUT.''

(iv) Illumination shall be provided for all working spaces about electric equipment.

(A) The lighting outlets shall be arranged so that persons changing lamps or making repairs on the lighting system will not be endangered by live parts or other equipment.

(B) The points of control shall be located so that persons are prevented from contacting any live part or moving part of the equipment while turning on the lights.

(v) Unguarded live parts above working space shall be maintained at elevations not less than specified in Table S–3.

(vi) Pipes or ducts that are foreign to the electrical installation and that require periodic maintenance or whose malfunction would endanger the operation of the electrical system may not be located in the vicinity of service equipment, metal-enclosed power switchgear, or industrial control assemblies. Protection shall be provided where necessary to avoid damage from condensation leaks and breaks in such foreign systems.

Note to paragraph (h)(5)(vi) of this section: Piping and other facilities are not considered foreign if provided for fire protection of the electrical installation.

TABLE S–2.—MINIMUM DEPTH OF CLEAR WORKING SPACE AT ELECTRIC EQUIPMENT, OVER 600 V

Nominal voltage to ground	Minimum clear distance for condition [2] [3]					
	Condition A		Condition B		Condition C	
	m	ft	m	ft	m	ft
601–2500 V	0.9	3.0	1.2	4.0	1.5	5.0
2501–9000 V	1.2	4.0	1.5	5.0	1.8	6.0
9001 V–25 kV	1.5	5.0	1.8	6.0	2.8	9.0
Over 25–75 kV [1]	1.8	6.0	2.5	8.0	3.0	10.0
Above 75 kV [1]	2.5	8.0	3.0	10.0	3.7	12.0

Notes to Table S–2:

[1] Minimum depth of clear working space in front of electric equipment with a nominal voltage to ground above 25,000 volts may be the same as that for 25,000 volts under Conditions A, B, and C for installations built before April 16, 1981.

[2] Conditions A, B, and C are as follows:

Condition A—Exposed live parts on one side and no live or grounded parts on the other side of the working space, or exposed live parts on both sides effectively guarded by suitable wood or other insulating material. Insulated wire or insulated busbars operating at not over 300 volts are not considered live parts.

Condition B—Exposed live parts on one side and grounded parts on the other side. Concrete, brick, and tile walls are considered as grounded surfaces.

Condition C—Exposed live parts on both sides of the work space (not guarded as provided in Condition A) with the operator between.

[3] Working space is not required in back of equipment such as dead-front switchboards or control assemblies that has no renewable or adjustable parts (such as fuses or switches) on the back and where all connections are accessible from locations other than the back. Where rear access is required to work on the deenergized parts on the back of enclosed equipment, a minimum working space 762 mm (30 in.) horizontally shall be provided.

TABLE S–3.—ELEVATION OF UNGUARDED LIVE PARTS ABOVE WORKING SPACE

Nominal voltage between phases	Elevation	
	m	ft
601–7500 V	[1] 2.81	[1] 9.01.
7501 V–35 kV	2.8	9.0.
Over 35 kV	2.8 + 9.5 mm/kV over 35 kV	9.0 + 0.37 in./kV over 35 kV.

[1] The minimum elevation may be 2.6 m (8.5 ft) for installations built before August 13, 2007. The minimum elevation may be 2.4 m (8.0 ft) for installations built before April 16, 1981, if the nominal voltage between phases is in the range of 601–6600 volts.

§ 1910.304 Wiring design and protection.

(a) *Use and identification of grounded and grounding conductors*—(1) *Identification of conductors.* (i) A conductor used as a grounded conductor shall be identifiable and distinguishable from all other conductors.

(ii) A conductor used as an equipment grounding conductor shall be identifiable and distinguishable from all other conductors.

(2) *Polarity of connections.* No grounded conductor may be attached to any terminal or lead so as to reverse designated polarity.

(3) *Use of grounding terminals and devices.* A grounding terminal or grounding-type device on a receptacle, cord connector, or attachment plug may not be used for purposes other than grounding.

(b) *Branch circuits*—(1) *Identification of multiwire branch circuits.* Where more than one nominal voltage system exists in a building containing multiwire branch circuits, each ungrounded conductor of a multiwire branch circuit, where accessible, shall be identified by phase and system. The means of identification shall be permanently posted at each branch-circuit panelboard.

(2) *Receptacles and cord connectors.* (i) Receptacles installed on 15- and 20-ampere branch circuits shall be of the grounding type except as permitted for replacement receptacles in paragraph (b)(2)(iv) of this section. Grounding-type receptacles shall be installed only on circuits of the voltage class and current for which they are rated, except as provided in Table S–4 and Table S–5.

(ii) Receptacles and cord connectors having grounding contacts shall have those contacts effectively grounded except for receptacles mounted on portable and vehicle-mounted generators in accordance with paragraph (g)(3) of this section and replacement

receptacles installed in accordance with paragraph (b)(2)(iv) of this section.

(iii) The grounding contacts of receptacles and cord connectors shall be grounded by connection to the equipment grounding conductor of the circuit supplying the receptacle or cord connector. The branch circuit wiring method shall include or provide an equipment grounding conductor to which the grounding contacts of the receptacle or cord connector shall be connected.

(iv) Replacement of receptacles shall comply with the following requirements:

(A) Where a grounding means exists in the receptacle enclosure or a grounding conductor is installed, grounding-type receptacles shall be used and shall be connected to the grounding means or conductor;

(B) Ground-fault circuit-interrupter protected receptacles shall be provided where replacements are made at receptacle outlets that are required to be so protected elsewhere in this subpart; and

(C) Where a grounding means does not exist in the receptacle enclosure, the installation shall comply with one of the following provisions:

(1) A nongrounding-type receptacle may be replaced with another nongrounding-type receptacle; or

(2) A nongrounding-type receptacle may be replaced with a ground-fault circuit-interrupter-type of receptacle that is marked ''No Equipment Ground;'' an equipment grounding conductor may not be connected from the ground-fault circuit-interrupter-type receptacle to any outlet supplied from the ground-fault circuit-interrupter receptacle; or

(3) A nongrounding-type receptacle may be replaced with a grounding-type receptacle where supplied through a ground-fault circuit-interrupter; the replacement receptacle shall be marked ''GFCI Protected'' and ''No Equipment Ground;'' an equipment grounding conductor may not be connected to such grounding-type receptacles.

(v) Receptacles connected to circuits having different voltages, frequencies, or types of current (ac or dc) on the same premises shall be of such design that the attachment plugs used on these circuits are not interchangeable.

(3) *Ground-fault circuit interrupter protection for personnel.* (i) All 125-volt, single-phase, 15- and 20-ampere receptacles installed in bathrooms or on rooftops shall have ground-fault circuit-interrupter protection for personnel.

(ii) The following requirements apply to temporary wiring installations that are used during maintenance, remodeling, or repair of buildings, structures, or equipment or during similar construction-like activities.

(A) All 125-volt, single-phase, 15-, 20-, and 30-ampere receptacle outlets that are not part of the permanent wiring of the building or structure and that are in use by personnel shall have ground-fault circuit-interrupter protection for personnel.

Note 1 to paragraph (b)(3)(ii)(A) of this section: A cord connector on an extension cord set is considered to be a receptacle outlet if the cord set is used for temporary electric power.

Note 2 to paragraph (b)(3)(ii)(A) of this section: Cord sets and devices incorporating the required ground-fault circuit-interrupter that are connected to the receptacle closest to the source of power are acceptable forms of protection.

(B) Receptacles other than 125 volt, single-phase, 15-, 20-, and 30-ampere receptacles that are not part of the permanent wiring of the building or structure and that are in use by personnel shall have ground-fault circuit-interrupter protection for personnel.

(C) Where the ground-fault circuit-interrupter protection required by paragraph (b)(3)(ii)(B) of this section is not available for receptacles other than 125-volt, single-phase, 15-, 20-, and 30-ampere, the employer shall establish and implement an assured equipment grounding conductor program covering cord sets, receptacles that are not a part of the building or structure, and equipment connected by cord and plug that are available for use or used by employees on those receptacles. This program shall comply with the following requirements:

(1) A written description of the program, including the specific procedures adopted by the employer, shall be available at the jobsite for inspection and copying by the Assistant Secretary of Labor and any affected employee;

(2) The employer shall designate one or more competent persons to implement the program;

(3) Each cord set, attachment cap, plug, and receptacle of cord sets, and any equipment connected by cord and plug, except cord sets and receptacles which are fixed and not exposed to damage, shall be visually inspected before each day's use for external defects, such as deformed or missing pins or insulation damage, and for indications of possible internal damage. Equipment found damaged or defective shall not be used until repaired;

(4) The following tests shall be performed on all cord sets and receptacles which are not a part of the permanent wiring of the building or structure, and cord- and plug-connected equipment required to be grounded:

(*i*) All equipment grounding conductors shall be tested for continuity and shall be electrically continuous;

(ii) Each receptacle and attachment cap or plug shall be tested for correct attachment of the equipment grounding conductor. The equipment grounding conductor shall be connected to its proper terminal; and

(iii) All required tests shall be performed before first use; before equipment is returned to service following any repairs; before equipment is used after any incident which can be reasonably suspected to have caused damage (for example, when a cord set is run over); and at intervals not to exceed 3 months, except that cord sets and receptacles which are fixed and not exposed to damage shall be tested at intervals not exceeding 6 months;

(5) The employer shall not make available or permit the use by employees of any equipment which has not met the requirements of paragraph (b)(3)(ii)(C) of this section; and

(6) Tests performed as required in paragraph (b)(3)(ii)(C) of this section shall be recorded. This test record shall identify each receptacle, cord set, and cord- and plug-connected equipment that passed the test and shall indicate the last date it was tested or the interval for which it was tested. This record shall be kept by means of logs, color coding, or other effective means and shall be maintained until replaced by a more current record. The record shall be made available on the jobsite for inspection by the Assistant Secretary and any affected employee.

(4) *Outlet devices.* Outlet devices shall have an ampere rating not less than the load to be served and shall comply with the following provisions:

(i) Where connected to a branch circuit having a rating in excess of 20 amperes, lampholders shall be of the heavy-duty type. A heavy-duty lampholder shall have a rating of not less than 660 watts if of the admedium type and not less than 750 watts if of any other type; and

(ii) Receptacle outlets shall comply with the following provisions:

(A) A single receptacle installed on an individual branch circuit shall have an ampere rating of not less than that of the branch circuit;

(B) Where connected to a branch circuit supplying two or more receptacles or outlets, a receptacle may not supply a total cord- and plug-connected load in excess of the maximum specified in Table S–4; and

(C) Where connected to a branch circuit supplying two or more receptacles or outlets, receptacle ratings shall conform to the values listed in Table S–5; or, where larger than 50 amperes, the receptacle rating may not be less than the branch-circuit rating. However, receptacles of cord- and plug-connected arc welders may have ampere ratings not less than the minimum branch-circuit conductor ampacity.

(5) *Cord connections.* A receptacle outlet shall be installed wherever flexible cords with attachment plugs are used. Where flexible cords are permitted to be permanently connected, receptacles may be omitted.

TABLE S–4.—MAXIMUM CORD- AND PLUG-CONNECTED LOAD TO RECEPTACLE

Circuit rating (amperes)	Receptacle rating (amperes)	Maximum load (amperes)
15 or 20	15	12

TABLE S–4.—MAXIMUM CORD- AND PLUG-CONNECTED LOAD TO RECEPTACLE—Continued

Circuit rating (amperes)	Receptacle rating (amperes)	Maximum load (amperes)
20	20	16
30	30	24

TABLE S–5.—RECEPTACLE RATINGS FOR VARIOUS SIZE CIRCUITS

Circuit rating (amperes)	Receptacle rating (amperes)
15	Not over 15.
20	15 or 20.
30	30.
40	40 or 50.
50	50.

(c) *Outside conductors, 600 volts, nominal, or less.* The following requirements apply to branch-circuit, feeder, and service conductors rated 600 volts, nominal, or less and run outdoors as open conductors.

(1) *Conductors on poles.* Conductors on poles shall have a separation of not less than 305 mm (1.0 ft) where not placed on racks or brackets. Conductors supported on poles shall provide a horizontal climbing space not less than the following:

(i) Power conductors below communication conductors—762 mm (30 in.);

(ii) Power conductors alone or above communication conductors:

(A) 300 volts or less—610 mm (24 in.),

(B) Over 300 volts—762 mm (30 in.);

(iii) Communication conductors below power conductors—same as power conductors; and

(iv) Communications conductors alone—no requirement.

(2) *Clearance from ground.* Open conductors, open multiconductor cables, and service-drop conductors of not over 600 volts, nominal, shall conform to the minimum clearances specified in Table S–6.

TABLE S–66.—CLEARANCES FROM GROUND

Distance	Installations built before August 13, 2007		Installations built on or after August 13, 2007	
	Maximum voltage	Conditions	Voltage to ground	Conditions
3.05 m (10.0 ft)	< 600 V	Above finished grade or sidewalks, or from any platform or projection from which they might be reached. (If these areas are accessible to other than pedestrian traffic, then one of the other conditions applies).	< 150 V	Above finished grade or sidewalks, or from any platform or projection from which they might be reached. (If these areas are accessible to other than pedestrian traffic, then one of the other conditions applies.)
3.66 m (12.0 ft)	< 600 V	Over areas, other than public streets, alleys, roads, and driveways, subject to vehicular traffic other than truck traffic.	< 300 V	Over residential property and driveways. Over commercial areas subject to pedestrian traffic or to vehicular traffic other than truck traffic. (This category includes conditions covered under the 3.05-m (10.0-ft) category where the voltage exceeds 150 V.)
4.57 m (15.0 ft)	< 600 V	Over areas, other than public streets, alleys, roads, and driveways, subject to truck traffic.	301 to 600 V	Over residential property and driveways. Over commercial areas subject to pedestrian traffic or to vehicular traffic other than truck traffic. (This category includes conditions covered under the 3.05-m (10.0-ft) category where the voltage exceeds 300 V.)
5.49 m (18.0 ft)	< 600 V	Over public streets, alleys, roads, and driveways.	< 600 V	Over public streets, alleys, roads, and driveways. Over commercial areas subject to truck traffic. Other land traversed by vehicles, including land used for cultivating or grazing and forests and orchards.

(3) *Clearance from building openings.* (i) Service conductors installed as open conductors or multiconductor cable without an overall outer jacket shall have a clearance of not less than 914 mm (3.0 ft) from windows that are designed to be opened, doors, porches, balconies, ladders, stairs, fire escapes, and similar locations. However, conductors that run above the top level of a window may be less than 914 mm (3.0 ft) from the window. Vertical clearance of final spans above, or within 914 mm (3.0 ft) measured horizontally of, platforms, projections, or surfaces from which they might be reached shall be maintained in accordance with paragraph (c)(2) of this section.

(ii) Overhead service conductors may not be installed beneath openings through which materials may be moved,

such as openings in farm and commercial buildings, and may not be installed where they will obstruct entrance to these building openings.

(4) *Above roofs.* Overhead spans of open conductors and open multiconductor cables shall have a vertical clearance of not less than 2.44 m (8.0 ft) above the roof surface. The vertical clearance above the roof level shall be maintained for a distance not less than 914 mm (3.0 ft) in all directions from the edge of the roof.

(i) The area above a roof surface subject to pedestrian or vehicular traffic shall have a vertical clearance from the roof surface in accordance with the clearance requirements of paragraph (c)(2) of this section.

(ii) A reduction in clearance to 914 mm (3.0 ft) is permitted where the voltage between conductors does not exceed 300 and the roof has a slope of 102 mm (4 in.) in 305 mm (12 in.) or greater.

(iii) A reduction in clearance above only the overhanging portion of the roof to not less than 457 mm (18 in.) is permitted where the voltage between conductors does not exceed 300 if:

(A) The conductors do not pass above the roof overhang for a distance of more than 1.83 m (6.0 ft), 1.22 m (4.0 ft) horizontally, and

(B) The conductors are terminated at a through-the-roof raceway or approved support.

(iv) The requirement for maintaining a vertical clearance of 914 mm (3.0 ft) from the edge of the roof does not apply to the final conductor span, where the conductors are attached to the side of a building.

(d) *Location of outdoor lamps.* Lamps for outdoor lighting shall be located below all energized conductors, transformers, or other electric equipment, unless such equipment is controlled by a disconnecting means that can be locked in the open position, or unless adequate clearances or other safeguards are provided for relamping operations.

(e) *Services*—(1) *Disconnecting means.* (i) Means shall be provided to disconnect all conductors in a building or other structure from the service-entrance conductors. The service disconnecting means shall plainly indicate whether it is in the open or closed position and shall be installed at a readily accessible location nearest the point of entrance of the service-entrance conductors.

(ii) Each service disconnecting means shall simultaneously disconnect all ungrounded conductors.

(iii) Each service disconnecting means shall be suitable for the prevailing conditions.

(2) *Services over 600 volts, nominal.* The following additional requirements apply to services over 600 volts, nominal.

(i) Service-entrance conductors installed as open wires shall be guarded to make them accessible only to qualified persons.

(ii) Signs warning of high voltage shall be posted where unqualified employees might come in contact with live parts.

(f) *Overcurrent protection*—(1) *600 volts, nominal, or less.* The following requirements apply to overcurrent protection of circuits rated 600 volts, nominal, or less.

(i) Conductors and equipment shall be protected from overcurrent in accordance with their ability to safely conduct current.

(ii) Except for motor running overload protection, overcurrent devices may not interrupt the continuity of the grounded conductor unless all conductors of the circuit are opened simultaneously.

(iii) A disconnecting means shall be provided on the supply side of all fuses in circuits over 150 volts to ground and cartridge fuses in circuits of any voltage where accessible to other than qualified persons so that each individual circuit containing fuses can be independently disconnected from the source of power. However, a current-limiting device without a disconnecting means is permitted on the supply side of the service disconnecting means. In addition, a single disconnecting means is permitted on the supply side of more than one set of fuses as permitted by the exception in § 1910.305(j)(4)(vi) for group operation of motors, and a single disconnecting means is permitted for fixed electric space-heating equipment.

(iv) Overcurrent devices shall be readily accessible to each employee or authorized building management personnel. These overcurrent devices may not be located where they will be exposed to physical damage or in the vicinity of easily ignitable material.

(v) Fuses and circuit breakers shall be so located or shielded that employees will not be burned or otherwise injured by their operation. Handles or levers of circuit breakers, and similar parts that may move suddenly in such a way that persons in the vicinity are likely to be injured by being struck by them, shall be guarded or isolated.

(vi) Circuit breakers shall clearly indicate whether they are in the open (off) or closed (on) position.

(vii) Where circuit breaker handles on switchboards are operated vertically rather than horizontally or rotationally, the up position of the handle shall be the closed (on) position.

(viii) Circuit breakers used as switches in 120-volt and 277-volt, fluorescent lighting circuits shall be listed and marked ''SWD.''

(ix) A circuit breaker with a straight voltage rating, such as 240 V or 480 V, may only be installed in a circuit in which the nominal voltage between any two conductors does not exceed the circuit breaker's voltage rating. A two-pole circuit breaker may not be used for protecting a 3-phase, corner-grounded delta circuit unless the circuit breaker is marked 1Φ—3Φ to indicate such suitability. A circuit breaker with a slash rating, such as 120/240 V or 480Y/277 V, may only be installed in a circuit where the nominal voltage of any conductor to ground does not exceed the lower of the two values of the circuit breaker's voltage rating and the nominal voltage between any two conductors does not exceed the higher value of the circuit breaker's voltage rating.

(2) *Feeders and branch circuits over 600 volts, nominal.* The following requirements apply to feeders and branch circuits energized at more than 600 volts, nominal:

(i) Feeder and branch-circuit conductors shall have overcurrent protection in each ungrounded conductor located at the point where the conductor receives its supply or at a location in the circuit determined under engineering supervision;

(A) Circuit breakers used for overcurrent protection of three-phase circuits shall have a minimum of three overcurrent relays operated from three current transformers. On three-phase, three-wire circuits, an overcurrent relay in the residual circuit of the current transformers may replace one of the phase relays. An overcurrent relay, operated from a current transformer that links all phases of a three-phase, three-wire circuit, may replace the residual relay and one other phase-conductor current transformer. Where the neutral is not grounded on the load side of the circuit, the current transformer may link all three phase conductors and the grounded circuit conductor (neutral); and

(B) If fuses are used for overcurrent protection, a fuse shall be connected in series with each ungrounded conductor;

(ii) Each protective device shall be capable of detecting and interrupting all values of current that can occur at its location in excess of its trip setting or melting point;

(iii) The operating time of the protective device, the available short-circuit current, and the conductor used

shall be coordinated to prevent damaging or dangerous temperatures in conductors or conductor insulation under short-circuit conditions; and

(iv) The following additional requirements apply to feeders only:

(A) The continuous ampere rating of a fuse may not exceed three times the ampacity of the conductors. The long-time trip element setting of a breaker or the minimum trip setting of an electronically actuated fuse may not exceed six times the ampacity of the conductor. For fire pumps, conductors may be protected for short circuit only; and

(B) Conductors tapped to a feeder may be protected by the feeder overcurrent device where that overcurrent device also protects the tap conductor.

(g) *Grounding.* Paragraphs (g)(1) through (g)(9) of this section contain grounding requirements for systems, circuits, and equipment.

(1) *Systems to be grounded.* Systems that supply premises wiring shall be grounded as follows:

(i) All 3-wire dc systems shall have their neutral conductor grounded;

(ii) Two-wire dc systems operating at over 50 volts through 300 volts between conductors shall be grounded unless:

(A) They supply only industrial equipment in limited areas and are equipped with a ground detector;

(B) They are rectifier-derived from an ac system complying with paragraphs (g)(1)(iii), (g)(1)(iv), and (g)(1)(v) of this section; or

(C) They are fire-alarm circuits having a maximum current of 0.030 amperes;

(iii) AC circuits of less than 50 volts shall be grounded if they are installed as overhead conductors outside of buildings or if they are supplied by transformers and the transformer primary supply system is ungrounded or exceeds 150 volts to ground;

(iv) AC systems of 50 volts to 1000 volts shall be grounded under any of the following conditions, unless exempted by paragraph (g)(1)(v) of this section:

(A) If the system can be so grounded that the maximum voltage to ground on the ungrounded conductors does not exceed 150 volts;

(B) If the system is nominally rated three-phase, four-wire wye connected in which the neutral is used as a circuit conductor;

(C) If the system is nominally rated three-phase, four-wire delta connected in which the midpoint of one phase is used as a circuit conductor; or

(D) If a service conductor is uninsulated;

(v) AC systems of 50 volts to 1000 volts are not required to be grounded under any of the following conditions:

(A) If the system is used exclusively to supply industrial electric furnaces for melting, refining, tempering, and the like;

(B) If the system is separately derived and is used exclusively for rectifiers supplying only adjustable speed industrial drives;

(C) If the system is separately derived and is supplied by a transformer that has a primary voltage rating less than 1000 volts, provided all of the following conditions are met:

(1) The system is used exclusively for control circuits;

(2) The conditions of maintenance and supervision ensure that only qualified persons will service the installation;

(3) Continuity of control power is required; and

(4) Ground detectors are installed on the control system;

(D) If the system is an isolated power system that supplies circuits in health care facilities; or

(E) If the system is a high-impedance grounded neutral system in which a grounding impedance, usually a resistor, limits the ground-fault current to a low value for 3-phase ac systems of 480 volts to 1000 volts provided all of the following conditions are met:

(1) The conditions of maintenance and supervision ensure that only qualified persons will service the installation;

(2) Continuity of power is required;

(3) Ground detectors are installed on the system; and

(4) Line-to-neutral loads are not served.

(2) *Conductor to be grounded.* The conductor to be grounded for ac premises wiring systems required to be grounded by paragraph (g)(1) of this section shall be as follows:

(i) One conductor of a single-phase, two-wire system shall be grounded;

(ii) The neutral conductor of a single-phase, three-wire system shall be grounded;

(iii) The common conductor of a multiphase system having one wire common to all phases shall be grounded;

(iv) One phase conductor of a multiphase system where one phase is grounded shall be grounded; and

(v) The neutral conductor of a multiphase system in which one phase is used as a neutral conductor shall be grounded.

(3) *Portable and vehicle-mounted generators.* (i) The frame of a portable generator need not be grounded and may serve as the grounding electrode for a system supplied by the generator under the following conditions:

(A) The generator supplies only equipment mounted on the generator or cord- and plug-connected equipment through receptacles mounted on the generator, or both; and

(B) The noncurrent-carrying metal parts of equipment and the equipment grounding conductor terminals of the receptacles are bonded to the generator frame.

(ii) The frame of a vehicle need not be grounded and may serve as the grounding electrode for a system supplied by a generator located on the vehicle under the following conditions:

(A) The frame of the generator is bonded to the vehicle frame;

(B) The generator supplies only equipment located on the vehicle and cord- and plug-connected equipment through receptacles mounted on the vehicle;

(C) The noncurrent-carrying metal parts of equipment and the equipment grounding conductor terminals of the receptacles are bonded to the generator frame; and

(D) The system complies with all other provisions of paragraph (g) of this section.

(iii) A system conductor that is required to be grounded by the provisions of paragraph (g)(2) of this section shall be bonded to the generator frame where the generator is a component of a separately derived system.

(4) *Grounding connections.* (i) For a grounded system, a grounding electrode conductor shall be used to connect both the equipment grounding conductor and the grounded circuit conductor to the grounding electrode. Both the equipment grounding conductor and the grounding electrode conductor shall be connected to the grounded circuit conductor on the supply side of the service disconnecting means or on the supply side of the system disconnecting means or overcurrent devices if the system is separately derived.

(ii) For an ungrounded service-supplied system, the equipment grounding conductor shall be connected to the grounding electrode conductor at the service equipment. For an ungrounded separately derived system, the equipment grounding conductor shall be connected to the grounding electrode conductor at, or ahead of, the system disconnecting means or overcurrent devices.

(iii) On extensions of existing branch circuits that do not have an equipment grounding conductor, grounding-type receptacles may be grounded to a grounded cold water pipe near the equipment if the extension was installed before August 13, 2007. When any

element of this branch circuit is replaced, the entire branch circuit shall use an equipment grounding conductor that complies with all other provisions of paragraph (g) of this section.

(5) *Grounding path.* The path to ground from circuits, equipment, and enclosures shall be permanent, continuous, and effective.

(6) *Supports, enclosures, and equipment to be grounded.* (i) Metal cable trays, metal raceways, and metal enclosures for conductors shall be grounded, except that:

(A) Metal enclosures such as sleeves that are used to protect cable assemblies from physical damage need not be grounded; and

(B) Metal enclosures for conductors added to existing installations of open wire, knob-and-tube wiring, and nonmetallic-sheathed cable need not be grounded if all of the following conditions are met:

(1) Runs are less than 7.62 meters (25.0 ft);

(2) Enclosures are free from probable contact with ground, grounded metal, metal laths, or other conductive materials; and

(3) Enclosures are guarded against employee contact.

(ii) Metal enclosures for service equipment shall be grounded.

(iii) Frames of electric ranges, wall-mounted ovens, counter-mounted cooking units, clothes dryers, and metal outlet or junction boxes that are part of the circuit for these appliances shall be grounded.

(iv) Exposed noncurrent-carrying metal parts of fixed equipment that may become energized shall be grounded under any of the following conditions:

(A) If within 2.44 m (8 ft) vertically or 1.52 m (5 ft) horizontally of ground or grounded metal objects and subject to employee contact;

(B) If located in a wet or damp location and not isolated;

(C) If in electrical contact with metal;

(D) If in a hazardous (classified) location;

(E) If supplied by a metal-clad, metal-sheathed, or grounded metal raceway wiring method; or

(F) If equipment operates with any terminal at over 150 volts to ground.

(v) Notwithstanding the provisions of paragraph (g)(6)(iv) of this section, exposed noncurrent-carrying metal parts of the following types of fixed equipment need not be grounded:

(A) Enclosures for switches or circuit breakers used for other than service equipment and accessible to qualified persons only;

(B) Electrically heated appliances that are permanently and effectively insulated from ground;

(C) Distribution apparatus, such as transformer and capacitor cases, mounted on wooden poles, at a height exceeding 2.44 m (8.0 ft) above ground or grade level; and

(D) Listed equipment protected by a system of double insulation, or its equivalent, and distinctively marked as such.

(vi) Exposed noncurrent-carrying metal parts of cord- and plug-connected equipment that may become energized shall be grounded under any of the following conditions:

(A) If in hazardous (classified) locations (see § 1910.307);

(B) If operated at over 150 volts to ground, except for guarded motors and metal frames of electrically heated appliances if the appliance frames are permanently and effectively insulated from ground;

(C) If the equipment is of the following types:

(1) Refrigerators, freezers, and air conditioners;

(2) Clothes-washing, clothes-drying, and dishwashing machines, sump pumps, and electric aquarium equipment;

(3) Hand-held motor-operated tools, stationary and fixed motor-operated tools, and light industrial motor-operated tools;

(4) Motor-operated appliances of the following types: hedge clippers, lawn mowers, snow blowers, and wet scrubbers;

(5) Cord- and plug-connected appliances used in damp or wet locations, or by employees standing on the ground or on metal floors or working inside of metal tanks or boilers;

(6) Portable and mobile X-ray and associated equipment;

(7) Tools likely to be used in wet and conductive locations; and

(8) Portable hand lamps.

(vii) Notwithstanding the provisions of paragraph (g)(6)(vi) of this section, the following equipment need not be grounded:

(A) Tools likely to be used in wet and conductive locations if supplied through an isolating transformer with an ungrounded secondary of not over 50 volts; and

(B) Listed or labeled portable tools and appliances if protected by an approved system of double insulation, or its equivalent, and distinctively marked.

(7) *Nonelectrical equipment.* The metal parts of the following nonelectrical equipment shall be grounded: frames and tracks of electrically operated cranes and hoists; frames of nonelectrically driven elevator cars to which electric conductors are attached; hand-operated metal shifting ropes or cables of electric elevators; and metal partitions, grill work, and similar metal enclosures around equipment of over 750 volts between conductors.

(8) *Methods of grounding fixed equipment.* (i) Noncurrent-carrying metal parts of fixed equipment, if required to be grounded by this subpart, shall be grounded by an equipment grounding conductor that is contained within the same raceway, cable, or cord, or runs with or encloses the circuit conductors. For dc circuits only, the equipment grounding conductor may be run separately from the circuit conductors.

(ii) Electric equipment is considered to be effectively grounded if it is secured to, and in electrical contact with, a metal rack or structure that is provided for its support and the metal rack or structure is grounded by the method specified for the noncurrent-carrying metal parts of fixed equipment in paragraph (g)(8)(i) of this section. Metal car frames supported by metal hoisting cables attached to or running over metal sheaves or drums of grounded elevator machines are also considered to be effectively grounded.

(iii) For installations made before April 16, 1981, electric equipment is also considered to be effectively grounded if it is secured to, and in metallic contact with, the grounded structural metal frame of a building. When any element of this branch circuit is replaced, the entire branch circuit shall use an equipment grounding conductor that complies with all other provisions of paragraph (g) of this section.

(9) *Grounding of systems and circuits of 1000 volts and over (high voltage).* If high voltage systems are grounded, they shall comply with all applicable provisions of paragraphs (g)(1) through (g)(8) of this section as supplemented and modified by the following requirements:

(i) Systems supplying portable or mobile high voltage equipment, other than substations installed on a temporary basis, shall comply with the following:

(A) The system shall have its neutral grounded through an impedance. If a delta-connected high voltage system is used to supply the equipment, a system neutral shall be derived.

(B) Exposed noncurrent-carrying metal parts of portable and mobile equipment shall be connected by an equipment grounding conductor to the point at which the system neutral impedance is grounded.

(C) Ground-fault detection and relaying shall be provided to

automatically deenergize any high voltage system component that has developed a ground fault. The continuity of the equipment grounding conductor shall be continuously monitored so as to deenergize automatically the high voltage feeder to the portable equipment upon loss of continuity of the equipment grounding conductor.

(D) The grounding electrode to which the portable equipment system neutral impedance is connected shall be isolated from and separated in the ground by at least 6.1 m (20.0 ft) from any other system or equipment grounding electrode, and there shall be no direct connection between the grounding electrodes, such as buried pipe, fence, and so forth.

(ii) All noncurrent-carrying metal parts of portable equipment and fixed equipment, including their associated fences, housings, enclosures, and supporting structures, shall be grounded. However, equipment that is guarded by location and isolated from ground need not be grounded. Additionally, pole-mounted distribution apparatus at a height exceeding 2.44 m (8.0 ft) above ground or grade level need not be grounded.

§ 1910.305 Wiring methods, components, and equipment for general use.

(a) *Wiring methods.* The provisions of this section do not apply to conductors that are an integral part of factory-assembled equipment.

(1) *General requirements.* (i) Metal raceways, cable trays, cable armor, cable sheath, enclosures, frames, fittings, and other metal noncurrent-carrying parts that are to serve as grounding conductors, with or without the use of supplementary equipment grounding conductors, shall be effectively bonded where necessary to ensure electrical continuity and the capacity to conduct safely any fault current likely to be imposed on them. Any nonconductive paint, enamel, or similar coating shall be removed at threads, contact points, and contact surfaces or be connected by means of fittings designed so as to make such removal unnecessary.

(ii) Where necessary for the reduction of electrical noise (electromagnetic interference) of the grounding circuit, an equipment enclosure supplied by a branch circuit may be isolated from a raceway containing circuits supplying only that equipment by one or more listed nonmetallic raceway fittings located at the point of attachment of the raceway to the equipment enclosure. The metal raceway shall be supplemented by an internal insulated equipment grounding conductor installed to ground the equipment enclosure.

(iii) No wiring systems of any type may be installed in ducts used to transport dust, loose stock, or flammable vapors. No wiring system of any type may be installed in any duct used for vapor removal or for ventilation of commercial-type cooking equipment, or in any shaft containing only such ducts.

(2) *Temporary wiring.* Except as specifically modified in this paragraph, all other requirements of this subpart for permanent wiring shall also apply to temporary wiring installations.

(i) Temporary electrical power and lighting installations of 600 volts, nominal, or less may be used only as follows:

(A) During and for remodeling, maintenance, or repair of buildings, structures, or equipment, and similar activities;

(B) For a period not to exceed 90 days for Christmas decorative lighting, carnivals, and similar purposes; or

(C) For experimental or development work, and during emergencies.

(ii) Temporary wiring shall be removed immediately upon completion of the project or purpose for which the wiring was installed.

(iii) Temporary electrical installations of more than 600 volts may be used only during periods of tests, experiments, emergencies, or construction-like activities.

(iv) The following requirements apply to feeders:

(A) Feeders shall originate in an approved distribution center.

(B) Conductors shall be run as multiconductor cord or cable assemblies. However, if installed as permitted in paragraph (a)(2)(i)(C) of this section, and if accessible only to qualified persons, feeders may be run as single insulated conductors.

(v) The following requirements apply to branch circuits:

(A) Branch circuits shall originate in an approved power outlet or panelboard.

(B) Conductors shall be multiconductor cord or cable assemblies or open conductors. If run as open conductors, they shall be fastened at ceiling height every 3.05 m (10.0 ft).

(C) No branch-circuit conductor may be laid on the floor.

(D) Each branch circuit that supplies receptacles or fixed equipment shall contain a separate equipment grounding conductor if run as open conductors.

(vi) Receptacles shall be of the grounding type. Unless installed in a continuous grounded metallic raceway or metallic covered cable, each branch circuit shall contain a separate equipment grounding conductor and all receptacles shall be electrically connected to the grounding conductor.

(vii) No bare conductors nor earth returns may be used for the wiring of any temporary circuit.

(viii) Suitable disconnecting switches or plug connectors shall be installed to permit the disconnection of all ungrounded conductors of each temporary circuit. Multiwire branch circuits shall be provided with a means to disconnect simultaneously all ungrounded conductors at the power outlet or panelboard where the branch circuit originated.

Note to paragraph (a)(2)(viii) of this section. Circuit breakers with their handles connected by approved handle ties are considered a single disconnecting means for the purpose of this requirement.

(ix) All lamps for general illumination shall be protected from accidental contact or breakage by a suitable fixture or lampholder with a guard. Brass shell, paper-lined sockets, or other metal-cased sockets may not be used unless the shell is grounded.

(x) Flexible cords and cables shall be protected from accidental damage, as might be caused, for example, by sharp corners, projections, and doorways or other pinch points.

(xi) Cable assemblies and flexible cords and cables shall be supported in place at intervals that ensure that they will be protected from physical damage. Support shall be in the form of staples, cables ties, straps, or similar type fittings installed so as not to cause damage.

(3) *Cable trays.* (i) Only the following wiring methods may be installed in cable tray systems: armored cable; electrical metallic tubing; electrical nonmetallic tubing; fire alarm cables; flexible metal conduit; flexible metallic tubing; instrumentation tray cable; intermediate metal conduit; liquidtight flexible metal conduit; liquidtight flexible nonmetallic conduit; metal-clad cable; mineral-insulated, metal-sheathed cable; multiconductor service-entrance cable; multiconductor underground feeder and branch-circuit cable; multipurpose and communications cables; nonmetallic-sheathed cable; power and control tray cable; power-limited tray cable; optical fiber cables; and other factory-assembled, multiconductor control, signal, or power cables that are specifically approved for installation in cable trays, rigid metal conduit, and rigid nonmetallic conduit.

(ii) In industrial establishments where conditions of maintenance and supervision assure that only qualified persons will service the installed cable

tray system, the following cables may also be installed in ladder, ventilated-trough, or ventilated-channel cable trays:

(A) Single conductor cable; the cable shall be No. 1/0 or larger and shall be of a type listed and marked on the surface for use in cable trays; where Nos. 1/0 through 4/0 single conductor cables are installed in ladder cable tray, the maximum allowable rung spacing for the ladder cable tray shall be 229 mm (9 in.); where exposed to direct rays of the sun, cables shall be identified as being sunlight resistant;

(B) Welding cables installed in dedicated cable trays;

(C) Single conductors used as equipment grounding conductors; these conductors, which may be insulated, covered, or bare, shall be No. 4 or larger; and

(D) Multiconductor cable, Type MV; where exposed to direct rays of the sun, the cable shall be identified as being sunlight resistant.

(iii) Metallic cable trays may be used as equipment grounding conductors only where continuous maintenance and supervision ensure that qualified persons will service the installed cable tray system.

(iv) Cable trays in hazardous (classified) locations may contain only the cable types permitted in such locations. (See § 1910.307.)

(v) Cable tray systems may not be used in hoistways or where subjected to severe physical damage.

(4) *Open wiring on insulators.* (i) Open wiring on insulators is only permitted on systems of 600 volts, nominal, or less for industrial or agricultural establishments, indoors or outdoors, in wet or dry locations, where subject to corrosive vapors, and for services.

(ii) Conductors smaller than No. 8 shall be rigidly supported on noncombustible, nonabsorbent insulating materials and may not contact any other objects. Supports shall be installed as follows:

(A) Within 152 mm (6 in.) from a tap or splice;

(B) Within 305 mm (12 in.) of a dead-end connection to a lampholder or receptacle; and

(C) At intervals not exceeding 1.37 m (4.5 ft), and at closer intervals sufficient to provide adequate support where likely to be disturbed.

(iii) In dry locations, where not exposed to severe physical damage, conductors may be separately enclosed in flexible nonmetallic tubing. The tubing shall be in continuous lengths not exceeding 4.57 m (15.0 ft) and secured to the surface by straps at intervals not exceeding 1.37 m (4.5 ft).

(iv) Open conductors shall be separated from contact with walls, floors, wood cross members, or partitions through which they pass by tubes or bushings of noncombustible, nonabsorbent insulating material. If the bushing is shorter than the hole, a waterproof sleeve of nonconductive material shall be inserted in the hole and an insulating bushing slipped into the sleeve at each end in such a manner as to keep the conductors absolutely out of contact with the sleeve. Each conductor shall be carried through a separate tube or sleeve.

(v) Where open conductors cross ceiling joints and wall studs and are exposed to physical damage (for example, located within 2.13 m (7.0 ft) of the floor), they shall be protected.

(b) *Cabinets, boxes, and fittings*—(1) *Conductors entering boxes, cabinets, or fittings.* (i) Conductors entering cutout boxes, cabinets, or fittings shall be protected from abrasion, and openings through which conductors enter shall be effectively closed.

(ii) Unused openings in cabinets, boxes, and fittings shall be effectively closed.

(iii) Where cable is used, each cable shall be secured to the cabinet, cutout box, or meter socket enclosure. However, where cable with an entirely nonmetallic sheath enters the top of a surface-mounted enclosure through one or more nonflexible raceways not less than 457 mm (18 in.) or more than 3.05 m (10.0 ft) in length, the cable need not be secured to the cabinet, box, or enclosure provided all of the following conditions are met:

(A) Each cable is fastened within 305 mm (12 in.) of the outer end of the raceway, measured along the sheath;

(B) The raceway extends directly above the enclosure and does not penetrate a structural ceiling;

(C) A fitting is provided on each end of the raceway to protect the cable from abrasion, and the fittings remain accessible after installation;

(D) The raceway is sealed or plugged at the outer end using approved means so as to prevent access to the enclosure through the raceway;

(E) The cable sheath is continuous through the raceway and extends into the enclosure not less than 6.35 mm (0.25 in.) beyond the fitting;

(F) The raceway is fastened at its outer end and at other points as necessary; and

(G) Where installed as conduit or tubing, the allowable cable fill does not exceed that permitted for complete conduit or tubing systems.

(2) *Covers and canopies.* (i) All pull boxes, junction boxes, and fittings shall be provided with covers identified for the purpose. If metal covers are used, they shall be grounded. In completed installations, each outlet box shall have a cover, faceplate, or fixture canopy. Covers of outlet boxes having holes through which flexible cord pendants pass shall be provided with bushings designed for the purpose or shall have smooth, well-rounded surfaces on which the cords may bear.

(ii) Where a fixture canopy or pan is used, any combustible wall or ceiling finish exposed between the edge of the canopy or pan and the outlet box shall be covered with noncombustible material.

(3) *Pull and junction boxes for systems over 600 volts, nominal.* In addition to other requirements in this section, the following requirements apply to pull and junction boxes for systems over 600 volts, nominal:

(i) Boxes shall provide a complete enclosure for the contained conductors or cables.

(ii) Boxes shall be closed by suitable covers securely fastened in place.

Note to paragraph (b)(3)(ii) of this section: Underground box covers that weigh over 45.4 kg (100 lbs) meet this requirement.

(iii) Covers for boxes shall be permanently marked ''HIGH VOLTAGE.'' The marking shall be on the outside of the box cover and shall be readily visible and legible.

(c) *Switches*—(1) *Single-throw knife switches.* Single-throw knife switches shall be so placed that gravity will not tend to close them. Single-throw knife switches approved for use in the inverted position shall be provided with a locking device that will ensure that the blades remain in the open position when so set.

(2) *Double-throw knife switches.* Double-throw knife switches may be mounted so that the throw will be either vertical or horizontal. However, if the throw is vertical, a locking device shall be provided to ensure that the blades remain in the open position when so set.

(3) *Connection of switches.* (i) Single-throw knife switches and switches with butt contacts shall be connected so that the blades are deenergized when the switch is in the open position.

(ii) Single-throw knife switches, molded-case switches, switches with butt contacts, and circuit breakers used as switches shall be connected so that the terminals supplying the load are deenergized when the switch is in the open position. However, blades and terminals supplying the load of a switch

may be energized when the switch is in the open position where the switch is connected to circuits or equipment inherently capable of providing a backfeed source of power. For such installations, a permanent sign shall be installed on the switch enclosure or immediately adjacent to open switches that read, ''WARNING—LOAD SIDE TERMINALS MAY BE ENERGIZED BY BACKFEED.''

(4) *Faceplates for flush-mounted snap switches.* Snap switches mounted in boxes shall have faceplates installed so as to completely cover the opening and seat against the finished surface.

(5) *Grounding.* Snap switches, including dimmer switches, shall be effectively grounded and shall provide a means to ground metal faceplates, whether or not a metal faceplate is installed. However, if no grounding means exists within the snap-switch enclosure, or where the wiring method does not include or provide an equipment ground, a snap switch without a grounding connection is permitted for replacement purposes only. Such snap switches shall be provided with a faceplate of nonconducting, noncombustible material if they are located within reach of conducting floors or other conducting surfaces.

(d) *Switchboards and panelboards*—(1) *Switchboards with exposed live parts.* Switchboards that have any exposed live parts shall be located in permanently dry locations and shall be accessible only to qualified persons.

(2) *Panelboard enclosures.* Panelboards shall be mounted in cabinets, cutout boxes, or enclosures designed for the purpose and shall be dead front. However, panelboards other than the dead front externally-operable type are permitted where accessible only to qualified persons.

(3) *Knife switches mounted in switchboards or panelboards.* Exposed blades of knife switches mounted in switchboards or panelboards shall be dead when open.

(e) *Enclosures for damp or wet locations*—(1) *Cabinets, cutout boxes, fittings, boxes, and panelboard enclosures.* Cabinets, cutout boxes, fittings, boxes, and panelboard enclosures in damp or wet locations shall be installed so as to prevent moisture or water from entering and accumulating within the enclosures and shall be mounted so there is at least 6.35-mm (0.25-in.) airspace between the enclosure and the wall or other supporting surface. However, nonmetallic enclosures may be installed without the airspace on a concrete, masonry, tile, or similar surface. The enclosures shall be weatherproof in wet locations.

(2) *Switches, circuit breakers, and switchboards.* Switches, circuit breakers, and switchboards installed in wet locations shall be enclosed in weatherproof enclosures.

(f) *Conductors for general wiring*—(1) *Insulation.* All conductors used for general wiring shall be insulated unless otherwise permitted in this subpart.

(2) *Type.* The conductor insulation shall be of a type that is approved for the voltage, operating temperature, and location of use.

(3) *Distinguishable.* Insulated conductors shall be distinguishable by appropriate color or other suitable means as being grounded conductors, ungrounded conductors, or equipment grounding conductors.

(g) *Flexible cords and cables*—(1)*Use of flexible cords and cables.* (i) Flexible cords and cables shall be approved for conditions of use and location.

(ii) Flexible cords and cables may be used only for:

(A) Pendants;

(B) Wiring of fixtures;

(C) Connection of portable lamps or appliances;

(D) Portable and mobile signs;

(E) Elevator cables;

(F) Wiring of cranes and hoists;

(G) Connection of stationary equipment to facilitate their frequent interchange;

(H) Prevention of the transmission of noise or vibration;

(I) Appliances where the fastening means and mechanical connections are designed to permit removal for maintenance and repair;

(J) Data processing cables approved as a part of the data processing system;

(K) Connection of moving parts; and

(L) Temporary wiring as permitted in paragraph (a)(2) of this section.

(iii) If used as permitted in paragraphs (g)(1)(ii)(C), (g)(1)(ii)(G), or (g)(1)(ii)(I) of this section, the flexible cord shall be equipped with an attachment plug and shall be energized from an approved receptacle outlet.

(iv) Unless specifically permitted otherwise in paragraph (g)(1)(ii) of this section, flexible cords and cables may not be used:

(A) As a substitute for the fixed wiring of a structure;

(B) Where run through holes in walls, ceilings, or floors;

(C) Where run through doorways, windows, or similar openings;

(D) Where attached to building surfaces;

(E) Where concealed behind building walls, ceilings, or floors; or

(F) Where installed in raceways, except as otherwise permitted in this subpart.

(v) Flexible cords used in show windows and showcases shall be Type S, SE, SEO, SEOO, SJ, SJE, SJEO, SJEOO, SJO, SJOO, SJT, SJTO, SJTOO, SO, SOO, ST, STO, or STOO, except for the wiring of chain-supported lighting fixtures and supply cords for portable lamps and other merchandise being displayed or exhibited.

(2) *Identification, splices, and terminations.* (i) A conductor of a flexible cord or cable that is used as a grounded conductor or an equipment grounding conductor shall be distinguishable from other conductors. Types S, SC, SCE, SCT, SE, SEO, SEOO, SJ, SJE, SJEO, SJEOO, SJO, SJT, SJTO, SJTOO, SO, SOO, ST, STO, and STOO flexible cords and Types G, G–GC, PPE, and W flexible cables shall be durably marked on the surface at intervals not exceeding 610 mm (24 in.) with the type designation, size, and number of conductors.

(ii) Flexible cords may be used only in continuous lengths without splice or tap. Hard-service cord and junior hard-service cord No. 14 and larger may be repaired if spliced so that the splice retains the insulation, outer sheath properties, and usage characteristics of the cord being spliced.

(iii) Flexible cords and cables shall be connected to devices and fittings so that strain relief is provided that will prevent pull from being directly transmitted to joints or terminal screws.

(h) *Portable cables over 600 volts, nominal.* This paragraph applies to portable cables used at more than 600 volts, nominal.

(1) *Conductor construction.* Multiconductor portable cable for use in supplying power to portable or mobile equipment at over 600 volts, nominal, shall consist of No. 8 or larger conductors employing flexible stranding. However, the minimum size of the insulated ground-check conductor of Type G–GC cables shall be No. 10.

(2) *Shielding.* Cables operated at over 2,000 volts shall be shielded for the purpose of confining the voltage stresses to the insulation.

(3) *Equipment grounding conductors.* Grounding conductors shall be provided.

(4) *Grounding shields.* All shields shall be grounded.

(5) *Minimum bending radii.* The minimum bending radii for portable cables during installation and handling in service shall be adequate to prevent damage to the cable.

(6) *Fittings.* Connectors used to connect lengths of cable in a run shall

be of a type that lock firmly together. Provisions shall be made to prevent opening or closing these connectors while energized. Strain relief shall be provided at connections and terminations.

(7) *Splices.* Portable cables may not be operated with splices unless the splices are of the permanent molded, vulcanized, or other approved type.

(8) *Terminations.* Termination enclosures shall be suitably marked with a high voltage hazard warning, and terminations shall be accessible only to authorized and qualified employees.

(i) *Fixture wires*—(1) *General.* Fixture wires shall be approved for the voltage, temperature, and location of use. A fixture wire which is used as a grounded conductor shall be identified.

(2) *Uses permitted.* Fixture wires may be used only:

(i) For installation in lighting fixtures and in similar equipment where enclosed or protected and not subject to bending or twisting in use; or

(ii) For connecting lighting fixtures to the branch-circuit conductors supplying the fixtures.

(3) *Uses not permitted.* Fixture wires may not be used as branch-circuit conductors except as permitted for Class 1 power limited circuits and for fire alarm circuits.

(j) *Equipment for general use*—(1) *Lighting fixtures, lampholders, lamps, and receptacles.* (i) Fixtures, lampholders, lamps, rosettes, and receptacles may have no live parts normally exposed to employee contact. However, rosettes and cleat-type lampholders and receptacles located at least 2.44 m (8.0 ft) above the floor may have exposed terminals.

(ii) Handlamps of the portable type supplied through flexible cords shall be equipped with a handle of molded composition or other material identified for the purpose, and a substantial guard shall be attached to the lampholder or the handle. Metal shell, paper-lined lampholders may not be used.

(iii) Lampholders of the screw-shell type shall be installed for use as lampholders only. Where supplied by a circuit having a grounded conductor, the grounded conductor shall be connected to the screw shell. Lampholders installed in wet or damp locations shall be of the weatherproof type.

(iv) Fixtures installed in wet or damp locations shall be identified for the purpose and shall be so constructed or installed that water cannot enter or accumulate in wireways, lampholders, or other electrical parts.

(2) *Receptacles, cord connectors, and attachment plugs (caps).* (i) All 15- and 20-ampere attachment plugs and connectors shall be constructed so that there are no exposed current-carrying parts except the prongs, blades, or pins. The cover for wire terminations shall be a part that is essential for the operation of an attachment plug or connector (dead-front construction). Attachment plugs shall be installed so that their prongs, blades, or pins are not energized unless inserted into an energized receptacle. No receptacles may be installed so as to require an energized attachment plug as its source of supply.

(ii) Receptacles, cord connectors, and attachment plugs shall be constructed so that no receptacle or cord connector will accept an attachment plug with a different voltage or current rating than that for which the device is intended. However, a 20-ampere T-slot receptacle or cord connector may accept a 15-ampere attachment plug of the same voltage rating.

(iii) Nongrounding-type receptacles and connectors may not be used for grounding-type attachment plugs.

(iv) A receptacle installed in a wet or damp location shall be suitable for the location.

(v) A receptacle installed outdoors in a location protected from the weather or in other damp locations shall have an enclosure for the receptacle that is weatherproof when the receptacle is covered (attachment plug cap not inserted and receptacle covers closed).

Note to paragraph (j)(2)(v) of this section. A receptacle is considered to be in a location protected from the weather when it is located under roofed open porches, canopies, marquees, or the like and where it will not be subjected to a beating rain or water runoff.

(vi) A receptacle installed in a wet location where the product intended to be plugged into it is not attended while in use (for example, sprinkler system controllers, landscape lighting, and holiday lights) shall have an enclosure that is weatherproof with the attachment plug cap inserted or removed.

(vii) A receptacle installed in a wet location where the product intended to be plugged into it will be attended while in use (for example, portable tools) shall have an enclosure that is weatherproof when the attachment plug cap is removed.

(3) *Appliances.* (i) Appliances may have no live parts normally exposed to contact other than parts functioning as open-resistance heating elements, such as the heating elements of a toaster, which are necessarily exposed.

(ii) Each appliance shall have a means to disconnect it from all ungrounded conductors. If an appliance is supplied by more than one source, the disconnecting means shall be grouped and identified.

(iii) Each electric appliance shall be provided with a nameplate giving the identifying name and the rating in volts and amperes, or in volts and watts. If the appliance is to be used on a specific frequency or frequencies, it shall be so marked. Where motor overload protection external to the appliance is required, the appliance shall be so marked.

(iv) Marking shall be located so as to be visible or easily accessible after installation.

(4) *Motors.* This paragraph applies to motors, motor circuits, and controllers.

(i) If specified in paragraph (j)(4) of this section that one piece of equipment shall be ''within sight of'' another piece of equipment, the piece of equipment shall be visible and not more than 15.24 m (50.0 ft) from the other.

(ii) An individual disconnecting means shall be provided for each controller. A disconnecting means shall be located within sight of the controller location. However, a single disconnecting means may be located adjacent to a group of coordinated controllers mounted adjacent to each other on a multi-motor continuous process machine. The controller disconnecting means for motor branch circuits over 600 volts, nominal, may be out of sight of the controller, if the controller is marked with a warning label giving the location and identification of the disconnecting means that is to be locked in the open position.

(iii) The disconnecting means shall disconnect the motor and the controller from all ungrounded supply conductors and shall be so designed that no pole can be operated independently.

(iv) The disconnecting means shall plainly indicate whether it is in the open (off) or closed (on) position.

(v) The disconnecting means shall be readily accessible. If more than one disconnect is provided for the same equipment, only one need be readily accessible.

(vi) An individual disconnecting means shall be provided for each motor, but a single disconnecting means may be used for a group of motors under any one of the following conditions:

(A) If a number of motors drive several parts of a single machine or piece of apparatus, such as a metal or woodworking machine, crane, or hoist;

(B) If a group of motors is under the protection of one set of branch-circuit protective devices; or

(C) If a group of motors is in a single room within sight of the location of the disconnecting means.

(vii) Motors, motor-control apparatus, and motor branch-circuit conductors shall be protected against overheating due to motor overloads or failure to start, and against short-circuits or ground faults. These provisions do not require overload protection that will stop a motor where a shutdown is likely to introduce additional or increased hazards, as in the case of fire pumps, or where continued operation of a motor is necessary for a safe shutdown of equipment or process and motor overload sensing devices are connected to a supervised alarm.

(viii) Where live parts of motors or controllers operating at over 150 volts to ground are guarded against accidental contact only by location, and where adjustment or other attendance may be necessary during the operation of the apparatus, suitable insulating mats or platforms shall be provided so that the attendant cannot readily touch live parts unless standing on the mats or platforms.

(5) *Transformers.* (i) Paragraph (j)(5) of this section covers the installation of all transformers except the following:

(A) Current transformers;

(B) Dry-type transformers installed as a component part of other apparatus;

(C) Transformers that are an integral part of an X-ray, high frequency, or electrostatic-coating apparatus;

(D) Transformers used with Class 2 and Class 3 circuits, sign and outline lighting, electric discharge lighting, and power-limited fire-alarm circuits; and

(E) Liquid-filled or dry-type transformers used for research, development, or testing, where effective safeguard arrangements are provided.

(ii) The operating voltage of exposed live parts of transformer installations shall be indicated by signs or visible markings on the equipment or structure.

(iii) Dry-type, high fire point liquid-insulated, and askarel-insulated transformers installed indoors and rated over 35kV shall be in a vault.

(iv) Oil-insulated transformers installed indoors shall be installed in a vault.

(v) Combustible material, combustible buildings and parts of buildings, fire escapes, and door and window openings shall be safeguarded from fires that may originate in oil-insulated transformers attached to or adjacent to a building or combustible material.

(vi) Transformer vaults shall be constructed so as to contain fire and combustible liquids within the vault and to prevent unauthorized access. Locks and latches shall be so arranged that a vault door can be readily opened from the inside.

(vii) Any pipe or duct system foreign to the electrical installation may not enter or pass through a transformer vault.

Note to paragraph (j)(5)(vii) of this section. Piping or other facilities provided for vault fire protection, or for transformer cooling, are not considered foreign to the electrical installation.

(viii) Material may not be stored in transformer vaults.

(6) *Capacitors.* (i) All capacitors, except surge capacitors or capacitors included as a component part of other apparatus, shall be provided with an automatic means of draining the stored charge after the capacitor is disconnected from its source of supply.

(ii) The following requirements apply to capacitors installed on circuits operating at more than 600 volts, nominal:

(A) Group-operated switches shall be used for capacitor switching and shall be capable of the following:

(1) Carrying continuously not less than 135 percent of the rated current of the capacitor installation;

(2) Interrupting the maximum continuous load current of each capacitor, capacitor bank, or capacitor installation that will be switched as a unit;

(3) Withstanding the maximum inrush current, including contributions from adjacent capacitor installations; and

(4) Carrying currents due to faults on the capacitor side of the switch;

(B) A means shall be installed to isolate from all sources of voltage each capacitor, capacitor bank, or capacitor installation that will be removed from service as a unit. The isolating means shall provide a visible gap in the electric circuit adequate for the operating voltage;

(C) Isolating or disconnecting switches (with no interrupting rating) shall be interlocked with the load interrupting device or shall be provided with prominently displayed caution signs to prevent switching load current; and

(D) For series capacitors, the proper switching shall be assured by use of at least one of the following:

(1) Mechanically sequenced isolating and bypass switches;

(2) Interlocks; or

(3) Switching procedure prominently displayed at the switching location.

(7) *Storage Batteries.* Provisions shall be made for sufficient diffusion and ventilation of gases from storage batteries to prevent the accumulation of explosive mixtures.

§ 1910.306 Specific purpose equipment and installations.

(a) *Electric signs and outline lighting*—(1) *Disconnecting means.* (i) Each sign and outline lighting system, or feeder circuit or branch circuit supplying a sign or outline lighting system, shall be controlled by an externally operable switch or circuit breaker that will open all ungrounded conductors. However, a disconnecting means is not required for an exit directional sign located within a building or for cord-connected signs with an attachment plug.

(ii) Signs and outline lighting systems located within fountains shall have the disconnect located at least 1.52 m (5.0 ft) from the inside walls of the fountain.

(2) *Location.* (i) The disconnecting means shall be within sight of the sign or outline lighting system that it controls. Where the disconnecting means is out of the line of sight from any section that may be energized, the disconnecting means shall be capable of being locked in the open position.

(ii) Signs or outline lighting systems operated by electronic or electromechanical controllers located external to the sign or outline lighting system may have a disconnecting means located within sight of the controller or in the same enclosure with the controller. The disconnecting means shall disconnect the sign or outline lighting system and the controller from all ungrounded supply conductors. It shall be designed so no pole can be operated independently and shall be capable of being locked in the open position.

(iii) Doors or covers giving access to uninsulated parts of indoor signs or outline lighting exceeding 600 volts and accessible to other than qualified persons shall either be provided with interlock switches to disconnect the primary circuit or shall be so fastened that the use of other than ordinary tools will be necessary to open them.

(b) *Cranes and hoists.* This paragraph applies to the installation of electric equipment and wiring used in connection with cranes, monorail hoists, hoists, and all runways.

(1) *Disconnecting means for runway conductors.* A disconnecting means shall be provided between the runway contact conductors and the power supply. Such disconnecting means shall consist of a motor-circuit switch, circuit breaker, or molded case switch. The disconnecting means shall open all ungrounded conductors simultaneously and shall be:

(i) Readily accessible and operable from the ground or floor level;

(ii) Arranged to be locked in the open position; and

(iii) Placed within view of the runway contact conductors.

(2) *Disconnecting means for cranes and monorail hoists.* (i) Except as provided in paragraph (b)(2)(iv) of this section, a motor-circuit switch, molded case switch, or circuit breaker shall be provided in the leads from the runway contact conductors or other power supply on all cranes and monorail hoists.

(ii) The disconnecting means shall be capable of being locked in the open position.

(iii) Means shall be provided at the operating station to open the power circuit to all motors of the crane or monorail hoist where the disconnecting means is not readily accessible from the crane or monorail hoist operating station.

(iv) The disconnecting means may be omitted where a monorail hoist or hand-propelled crane bridge installation meets all of the following conditions:

(A) The unit is controlled from the ground or floor level;

(B) The unit is within view of the power supply disconnecting means; and

(C) No fixed work platform has been provided for servicing the unit.

(3) *Limit switch.* A limit switch or other device shall be provided to prevent the load block from passing the safe upper limit of travel of any hoisting mechanism.

(4) *Clearance.* The dimension of the working space in the direction of access to live parts that may require examination, adjustment, servicing, or maintenance while alive shall be a minimum of 762 mm (2.5 ft). Where controls are enclosed in cabinets, the doors shall either open at least 90 degrees or be removable.

(c) *Elevators, dumbwaiters, escalators, moving walks, wheelchair lifts, and stairway chair lifts.* The following requirements apply to elevators, dumbwaiters, escalators, moving walks, wheelchair lifts, and stairway chair lifts.

(1) *Disconnecting means.* Elevators, dumbwaiters, escalators, moving walks, wheelchair lifts, and stairway chair lifts shall have a single means for disconnecting all ungrounded main power supply conductors for each unit.

(2) *Control panels.* Control panels not located in the same space as the drive machine shall be located in cabinets with doors or panels capable of being locked closed.

(3) *Type.* The disconnecting means shall be an enclosed externally operable fused motor circuit switch or circuit breaker capable of being locked in the open position. The disconnecting means shall be a listed device.

(4) *Operation.* No provision may be made to open or close this disconnecting means from any other part of the premises. If sprinklers are installed in hoistways, machine rooms, or machinery spaces, the disconnecting means may automatically open the power supply to the affected elevators prior to the application of water. No provision may be made to close this disconnecting means automatically (that is, power may only be restored by manual means).

(5) *Location.* The disconnecting means shall be located where it is readily accessible to qualified persons.

(i) On elevators without generator field control, the disconnecting means shall be located within sight of the motor controller. Driving machines or motion and operation controllers not within sight of the disconnecting means shall be provided with a manually operated switch installed in the control circuit adjacent to the equipment in order to prevent starting. Where the driving machine is located in a remote machinery space, a single disconnecting means for disconnecting all ungrounded main power supply conductors shall be provided and be capable of being locked in the open position.

(ii) On elevators with generator field control, the disconnecting means shall be located within sight of the motor controller for the driving motor of the motor-generator set. Driving machines, motor-generator sets, or motion and operation controllers not within sight of the disconnecting means shall be provided with a manually operated switch installed in the control circuit to prevent starting. The manually operated switch shall be installed adjacent to this equipment. Where the driving machine or the motor-generator set is located in a remote machinery space, a single means for disconnecting all ungrounded main power supply conductors shall be provided and be capable of being locked in the open position.

(iii) On escalators and moving walks, the disconnecting means shall be installed in the space where the controller is located.

(iv) On wheelchair lifts and stairway chair lifts, the disconnecting means shall be located within sight of the motor controller.

(6) *Identification and signs.* (i) Where there is more than one driving machine in a machine room, the disconnecting means shall be numbered to correspond to the identifying number of the driving machine that they control.

(ii) The disconnecting means shall be provided with a sign to identify the location of the supply-side overcurrent protective device.

(7) *Single-car and multicar installations.* On single-car and multicar installations, equipment receiving electrical power from more than one source shall be provided with a disconnecting means for each source of electrical power. The disconnecting means shall be within sight of the equipment served.

(8) *Warning sign for multiple disconnecting means.* A warning sign shall be mounted on or next to the disconnecting means where multiple disconnecting means are used and parts of the controllers remain energized from a source other than the one disconnected. The sign shall be clearly legible and shall read ''WARNING—PARTS OF THE CONTROLLER ARE NOT DEENERGIZED BY THIS SWITCH.''

(9) *Interconnection between multicar controllers.* A warning sign worded as required in paragraph (c)(8) of this section shall be mounted on or next to the disconnecting means where interconnections between controllers are necessary for the operation of the system on multicar installations that remain energized from a source other than the one disconnected.

(10) *Motor controllers.* Motor controllers may be located outside the spaces otherwise required by paragraph (c) of this section, provided they are in enclosures with doors or removable panels capable of being locked closed and the disconnecting means is located adjacent to or is an integral part of the motor controller. Motor controller enclosures for escalators or moving walks may be located in the balustrade on the side located away from the moving steps or moving treadway. If the disconnecting means is an integral part of the motor controller, it shall be operable without opening the enclosure.

(d) *Electric welders—disconnecting means*—(1) *Arc welders.* A disconnecting means shall be provided in the supply circuit for each arc welder that is not equipped with a disconnect mounted as an integral part of the welder. The disconnecting means shall be a switch or circuit breaker, and its rating may not be less than that necessary to accommodate overcurrent protection.

(2) *Resistance welders.* A switch or circuit breaker shall be provided by which each resistance welder and its control equipment can be disconnected from the supply circuit. The ampere rating of this disconnecting means may not be less than the supply conductor ampacity. The supply circuit switch may be used as the welder

disconnecting means where the circuit supplies only one welder.

(e) *Information technology equipment*—(1) *Disconnecting means.* A means shall be provided to disconnect power to all electronic equipment in an information technology equipment room. There shall also be a similar means to disconnect the power to all dedicated heating, ventilating, and air-conditioning (HVAC) systems serving the room and to cause all required fire/smoke dampers to close.

(2) *Grouping.* The control for these disconnecting means shall be grouped and identified and shall be readily accessible at the principal exit doors. A single means to control both the electronic equipment and HVAC system is permitted.

(3) *Exception.* Integrated electrical systems covered by § 1910.308(g) need not have the disconnecting means required by paragraph (e)(1) of this section.

(f) *X-Ray equipment.* This paragraph applies to X-ray equipment.

(1) *Disconnecting means.* (i) A disconnecting means shall be provided in the supply circuit. The disconnecting means shall be operable from a location readily accessible from the X-ray control. For equipment connected to a 120-volt branch circuit of 30 amperes or less, a grounding-type attachment plug cap and receptacle of proper rating may serve as a disconnecting means.

(ii) If more than one piece of equipment is operated from the same high-voltage circuit, each piece or each group of equipment as a unit shall be provided with a high-voltage switch or equivalent disconnecting means. The disconnecting means shall be constructed, enclosed, or located so as to avoid contact by employees with its live parts.

(2) *Control.* The following requirements apply to industrial and commercial laboratory equipment.

(i) Radiographic and fluoroscopic-type equipment shall be effectively enclosed or shall have interlocks that deenergize the equipment automatically to prevent ready access to live current-carrying parts.

(ii) Diffraction- and irradiation-type equipment shall have a pilot light, readable meter deflection, or equivalent means to indicate when the equipment is energized, unless the equipment or installation is effectively enclosed or is provided with interlocks to prevent access to live current-carrying parts during operation.

(g) *Induction and dielectric heating equipment.* This paragraph applies to induction and dielectric heating equipment and accessories for industrial and scientific applications, but not for medical or dental applications or for appliances.

(1) *Guarding and grounding.* (i) The converting apparatus (including the dc line) and high-frequency electric circuits (excluding the output circuits and remote-control circuits) shall be completely contained within enclosures of noncombustible material.

(ii) All panel controls shall be of dead-front construction.

(iii) Doors or detachable panels shall be employed for internal access. Where doors are used giving access to voltages from 500 to 1000 volts ac or dc, either door locks shall be provided or interlocks shall be installed. Where doors are used giving access to voltages of over 1000 volts ac or dc, either mechanical lockouts with a disconnecting means to prevent access until circuit parts within the cubicle are deenergized, or both door interlocking and mechanical door locks, shall be provided. Detachable panels not normally used for access to such parts shall be fastened in a manner that will make them difficult to remove (for example, by requiring the use of tools).

(iv) Warning labels or signs that read ''DANGER—HIGH VOLTAGE—KEEP OUT'' shall be attached to the equipment and shall be plainly visible where persons might contact energized parts when doors are opened or closed or when panels are removed from compartments containing over 250 volts ac or dc.

(v) Induction and dielectric heating equipment shall be protected as follows:

(A) Protective cages or adequate shielding shall be used to guard work applicators other than induction heating coils.

(B) Induction heating coils shall be protected by insulation or refractory materials or both.

(C) Interlock switches shall be used on all hinged access doors, sliding panels, or other such means of access to the applicator, unless the applicator is an induction heating coil at dc ground potential or operating at less than 150 volts ac.

(D) Interlock switches shall be connected in such a manner as to remove all power from the applicator when any one of the access doors or panels is open.

(vi) A readily accessible disconnecting means shall be provided by which each heating equipment can be isolated from its supply circuit. The ampere rating of this disconnecting means may not be less than the nameplate current rating of the equipment. The supply circuit disconnecting means is permitted as a heating equipment disconnecting means where the circuit supplies only one piece of equipment.

(2) *Remote control.* (i) If remote controls are used for applying power, a selector switch shall be provided and interlocked to provide power from only one control point at a time.

(ii) Switches operated by foot pressure shall be provided with a shield over the contact button to avoid accidental closing of the switch.

(h) *Electrolytic cells.* This paragraph applies to the installation of the electrical components and accessory equipment of electrolytic cells, electrolytic cell lines, and process power supply for the production of aluminum, cadmium, chlorine, copper, fluorine, hydrogen peroxide, magnesium, sodium, sodium chlorate, and zinc. Cells used as a source of electric energy and for electroplating processes and cells used for production of hydrogen are not covered by this paragraph.

(1) *Application.* Installations covered by paragraph (h) of this section shall comply with all applicable provisions of this subpart, except as follows:

(i) Overcurrent protection of electrolytic cell dc process power circuits need not comply with the requirements of § 1910.304(f);

(ii) Equipment located or used within the cell line working zone or associated with the cell line dc power circuits need not comply with the provisions of § 1910.304(g); and

(iii) Electrolytic cells, cell line conductors, cell line attachments, and the wiring of auxiliary equipment and devices within the cell line working zone need not comply with the provisions of § 1910.303 or § 1910.304(b) and (c).

(2) *Disconnecting means.* If more than one dc cell line process power supply serves the same cell line, a disconnecting means shall be provided on the cell line circuit side of each power supply to disconnect it from the cell line circuit. Removable links or removable conductors may be used as the disconnecting means.

(3) *Portable electric equipment.* (i) The frames and enclosures of portable electric equipment used within the cell line working zone may not be grounded, unless the cell line circuit voltage does not exceed 200 volts DC or the frames are guarded.

(ii) Ungrounded portable electric equipment shall be distinctively marked and shall employ plugs and receptacles of a configuration that prevents connection of this equipment to grounding receptacles and that prevents inadvertent interchange of ungrounded

and grounded portable electric equipment.

(4) *Power supply circuits and receptacles for portable electric equipment.* (i) Circuits supplying power to ungrounded receptacles for hand-held, cord- and plug-connected equipment shall meet the following requirements:

(A) The circuits shall be electrically isolated from any distribution system supplying areas other than the cell line working zone and shall be ungrounded;

(B) The circuits shall be supplied through isolating transformers with primaries operating at not more than 600 volts between conductors and protected with proper overcurrent protection;

(C) The secondary voltage of the isolating transformers may not exceed 300 volts between conductors; and

(D) All circuits supplied from the secondaries shall be ungrounded and shall have an approved overcurrent device of proper rating in each conductor.

(ii) Receptacles and their mating plugs for ungrounded equipment may not have provision for a grounding conductor and shall be of a configuration that prevents their use for equipment required to be grounded.

(iii) Receptacles on circuits supplied by an isolating transformer with an ungrounded secondary:

(A) Shall have a distinctive configuration;

(B) Shall be distinctively marked; and

(C) May not be used in any other location in the facility.

(5) *Fixed and portable electric equipment.* (i) The following need not be grounded:

(A) AC systems supplying fixed and portable electric equipment within the cell line working zone; and

(B) Exposed conductive surfaces, such as electric equipment housings, cabinets, boxes, motors, raceways and the like that are within the cell line working zone.

(ii) Auxiliary electric equipment, such as motors, transducers, sensors, control devices, and alarms, mounted on an electrolytic cell or other energized surface shall be connected to the premises wiring systems by any of the following means:

(A) Multiconductor hard usage or extra hard usage flexible cord;

(B) Wire or cable in suitable nonmetallic raceways or cable trays; or

(C) Wire or cable in suitable metal raceways or metal cable trays installed with insulating breaks such that they will not cause a potentially hazardous electrical condition.

(iii) Fixed electric equipment may be bonded to the energized conductive surfaces of the cell line, its attachments, or auxiliaries. If fixed electric equipment is mounted on an energized conductive surface, it shall be bonded to that surface.

(6) *Auxiliary nonelectrical connections.* Auxiliary nonelectrical connections such as air hoses, water hoses, and the like, to an electrolytic cell, its attachments, or auxiliary equipment may not have continuous conductive reinforcing wire, armor, braids, or the like. Hoses shall be of a nonconductive material.

(7) *Cranes and hoists.* (i) The conductive surfaces of cranes and hoists that enter the cell line working zone need not be grounded. The portion of an overhead crane or hoist that contacts an energized electrolytic cell or energized attachments shall be insulated from ground.

(ii) Remote crane or hoist controls that may introduce hazardous electrical conditions into the cell line working zone shall employ one or more of the following systems:

(A) Isolated and ungrounded control circuit;

(B) Nonconductive rope operator;

(C) Pendant pushbutton with nonconductive supporting means and with nonconductive surfaces or ungrounded exposed conductive surfaces; or

(D) Radio.

(i) *Electrically driven or controlled irrigation machines*—(1) *Lightning protection.* If an irrigation machine has a stationary point, a grounding electrode system shall be connected to the machine at the stationary point for lightning protection.

(2) *Disconnecting means.* (i) The main disconnecting means for a center pivot irrigation machine shall be located at the point of connection of electrical power to the machine or shall be visible and not more than 15.2 m (50 ft) from the machine.

(ii) The disconnecting means shall be readily accessible and capable of being locked in the open position.

(iii) A disconnecting means shall be provided for each motor and controller.

(j) *Swimming pools, fountains, and similar installations.* This paragraph applies to electric wiring for and equipment in or adjacent to all swimming, wading, therapeutic, and decorative pools and fountains; hydro-massage bathtubs, whether permanently installed or storable; and metallic auxiliary equipment, such as pumps, filters, and similar equipment. Therapeutic pools in health care facilities are exempt from these provisions.

(1) *Receptacles.* (i) A single receptacle of the locking and grounding type that provides power for a permanently installed swimming pool recirculating pump motor may be located not less than 1.52 m (5 ft) from the inside walls of a pool. All other receptacles on the property shall be located at least 3.05 m (10 ft) from the inside walls of a pool.

(ii) Receptacles that are located within 4.57 m (15 ft), or 6.08 m (20 ft) if the installation was built after August 13, 2007, of the inside walls of the pool shall be protected by ground-fault circuit interrupters.

(iii) Where a pool is installed permanently at a dwelling unit, at least one 125-volt, 15- or 20-ampere receptacle on a general-purpose branch circuit shall be located a minimum of 3.05 m (10 ft) and not more than 6.08 m (20 ft) from the inside wall of the pool. This receptacle shall be located not more than 1.98 m (6.5 ft) above the floor, platform, or grade level serving the pool.

Note to paragraph (j)(1) of this section: In determining these dimensions, the distance to be measured is the shortest path the supply cord of an appliance connected to the receptacle would follow without piercing a floor, wall, or ceiling of a building or other effective permanent barrier.

(2) *Lighting fixtures, lighting outlets, and ceiling suspended (paddle) fans.* (i) In outdoor pool areas, lighting fixtures, lighting outlets, and ceiling-suspended (paddle) fans may not be installed over the pool or over the area extending 1.52 m (5 ft) horizontally from the inside walls of a pool unless no part of the lighting fixture of a ceiling-suspended (paddle) fan is less than 3.66 m (12 ft) above the maximum water level. However, a lighting fixture or lighting outlet that was installed before April 16, 1981, may be located less than 1.52 m (5 ft) measured horizontally from the inside walls of a pool if it is at least 1.52 m (5 ft) above the surface of the maximum water level and is rigidly attached to the existing structure. It shall also be protected by a ground-fault circuit interrupter installed in the branch circuit supplying the fixture.

(ii) Lighting fixtures and lighting outlets installed in the area extending between 1.52 m (5 ft) and 3.05 m (10 ft) horizontally from the inside walls of a pool shall be protected by a ground-fault circuit interrupter unless installed 1.52 m (5 ft) above the maximum water level and rigidly attached to the structure adjacent to or enclosing the pool.

(3) *Cord- and plug-connected equipment.* Flexible cords used with the following equipment may not exceed 0.9 m (3 ft) in length and shall have a

copper equipment grounding conductor with a grounding-type attachment plug:

(i) Cord- and plug-connected lighting fixtures installed within 4.88 m (16 ft) of the water surface of permanently installed pools; and

(ii) Other cord- and plug-connected, fixed or stationary equipment used with permanently installed pools.

(4) *Underwater equipment.* (i) A ground-fault circuit interrupter shall be installed in the branch circuit supplying underwater fixtures operating at more than 15 volts. Equipment installed underwater shall be identified for the purpose.

(ii) No underwater lighting fixtures may be installed for operation at over 150 volts between conductors.

(iii) A lighting fixture facing upward shall have the lens adequately guarded to prevent contact by any person.

(5) *Fountains.* All electric equipment, including power supply cords, operating at more than 15 volts and used with fountains shall be protected by ground-fault circuit interrupters.

(k) *Carnivals, circuses, fairs, and similar events.* This paragraph covers the installation of portable wiring and equipment, including wiring in or on all structures, for carnivals, circuses, exhibitions, fairs, traveling attractions, and similar events.

(1) *Protection of electric equipment.* Electric equipment and wiring methods in or on rides, concessions, or other units shall be provided with mechanical protection where such equipment or wiring methods are subject to physical damage.

(2) *Installation.* (i) Services shall be installed in accordance with applicable requirements of this subpart, and, in addition, shall comply with the following:

(A) Service equipment may not be installed in a location that is accessible to unqualified persons, unless the equipment is lockable; and

(B) Service equipment shall be mounted on solid backing and installed so as to be protected from the weather, unless the equipment is of weatherproof construction.

(ii) Amusement rides and amusement attractions shall be maintained not less than 4.57 m (15 ft) in any direction from overhead conductors operating at 600 volts or less, except for the conductors supplying the amusement ride or attraction. Amusement rides or attractions may not be located under or within 4.57 m (15 ft) horizontally of conductors operating in excess of 600 volts.

(iii) Flexible cords and cables shall be listed for extra-hard usage. When used outdoors, flexible cords and cables shall also be listed for wet locations and shall be sunlight resistant.

(iv) Single conductor cable shall be size No. 2 or larger.

(v) Open conductors are prohibited except as part of a listed assembly or festoon lighting installed in accordance with § 1910.304(c).

(vi) Flexible cords and cables shall be continuous without splice or tap between boxes or fittings. Cord connectors may not be laid on the ground unless listed for wet locations. Connectors and cable connections may not be placed in audience traffic paths or within areas accessible to the public unless guarded.

(vii) Wiring for an amusement ride, attraction, tent, or similar structure may not be supported by another ride or structure unless specifically identified for the purpose.

(viii) Flexible cords and cables run on the ground, where accessible to the public, shall be covered with approved nonconductive mats. Cables and mats shall be arranged so as not to present a tripping hazard.

(ix) A box or fitting shall be installed at each connection point, outlet, switch point, or junction point.

(3) *Inside tents and concessions.* Electrical wiring for temporary lighting, where installed inside of tents and concessions, shall be securely installed, and, where subject to physical damage, shall be provided with mechanical protection. All temporary lamps for general illumination shall be protected from accidental breakage by a suitable fixture or lampholder with a guard.

(4) *Portable distribution and termination boxes.* Employers may only use portable distribution and termination boxes that meet the following requirements:

(i) Boxes shall be designed so that no live parts are exposed to accidental contact. Where installed outdoors, the box shall be of weatherproof construction and mounted so that the bottom of the enclosure is not less than 152 mm (6 in.) above the ground;

(ii) Busbars shall have an ampere rating not less than the overcurrent device supplying the feeder supplying the box. Busbar connectors shall be provided where conductors terminate directly on busbars;

(iii) Receptacles shall have overcurrent protection installed within the box. The overcurrent protection may not exceed the ampere rating of the receptacle, except as permitted in § 1910.305(j)(4) for motor loads;

(iv) Where single-pole connectors are used, they shall comply with the following:

(A) Where ac single-pole portable cable connectors are used, they shall be listed and of the locking type. Where paralleled sets of current-carrying single-pole separable connectors are provided as input devices, they shall be prominently labeled with a warning indicating the presence of internal parallel connections. The use of single-pole separable connectors shall comply with at least one of the following conditions:

(1) Connection and disconnection of connectors are only possible where the supply connectors are interlocked to the source and it is not possible to connect or disconnect connectors when the supply is energized; or

(2) Line connectors are of the listed sequential-interlocking type so that load connectors are connected in the following sequence:

(i) Equipment grounding conductor connection;

(ii) Grounded circuit-conductor connection, if provided; and

(iii) Ungrounded conductor connection; and so that disconnection is in the reverse order; or

(3) A caution notice is provided adjacent to the line connectors indicating that plug connection must be in the following sequence:

(i) Equipment grounding conductor connection;

(ii) Grounded circuit-conductor connection, if provided; and

(iii) Ungrounded conductor connection; and indicating that disconnection is in the reverse order; and

(B) Single-pole separable connectors used in portable professional motion picture and television equipment may be interchangeable for ac or dc use or for different current ratings on the same premises only if they are listed for ac/dc use and marked to identify the system to which they are connected;

(v) Overcurrent protection of equipment and conductors shall be provided; and

(vi) The following equipment connected to the same source shall be bonded:

(A) Metal raceways and metal sheathed cable;

(B) Metal enclosures of electrical equipment; and

(C) Metal frames and metal parts of rides, concessions, trailers, trucks, or other equipment that contain or support electrical equipment.

(5) *Disconnecting means.* (i) Each ride and concession shall be provided with a fused disconnect switch or circuit breaker located within sight and within 1.83 m (6 ft) of the operator's station.

(ii) The disconnecting means shall be readily accessible to the operator, including when the ride is in operation.

(iii) Where accessible to unqualified persons, the enclosure for the switch or circuit breaker shall be of the lockable type.

(iv) A shunt trip device that opens the fused disconnect or circuit breaker when a switch located in the ride operator's console is closed is a permissible method of opening the circuit.

§ 1910.307 Hazardous (classified) locations.

(a) *Scope*—(1) *Applicability.* This section covers the requirements for electric equipment and wiring in locations that are classified depending on the properties of the flammable vapors, liquids or gases, or combustible dusts or fibers that may be present therein and the likelihood that a flammable or combustible concentration or quantity is present. Hazardous (classified) locations may be found in occupancies such as, but not limited to, the following: aircraft hangars, gasoline dispensing and service stations, bulk storage plants for gasoline or other volatile flammable liquids, paint-finishing process plants, health care facilities, agricultural or other facilities where excessive combustible dusts may be present, marinas, boat yards, and petroleum and chemical processing plants. Each room, section or area shall be considered individually in determining its classification.

(2) *Classifications.* (i) These hazardous (classified) locations are assigned the following designations:

(A) Class I, Division 1

(B) Class I, Division 2

(C) Class I, Zone 0

(D) Class I, Zone 1

(E) Class I, Zone 2

(F) Class II, Division 1

(G) Class II, Division 2

(H) Class III, Division 1

(I) Class III, Division 2

(ii) For definitions of these locations, see § 1910.399.

(3) *Other sections of this subpart.* All applicable requirements in this subpart apply to hazardous (classified) locations unless modified by provisions of this section.

(4) *Division and zone classification.* In Class I locations, an installation must be classified as using the division classification system meeting paragraphs (c), (d), (e), and (f) of this section or using the zone classification system meeting paragraph (g) of this section. In Class II and Class III locations, an installation must be classified using the division classification system meeting paragraphs (c), (d), (e), and (f) of this section.

(b) *Documentation.* All areas designated as hazardous (classified) locations under the Class and Zone system and areas designated under the Class and Division system established after August 13, 2007 shall be properly documented. This documentation shall be available to those authorized to design, install, inspect, maintain, or operate electric equipment at the location.

(c) *Electrical installations.* Equipment, wiring methods, and installations of equipment in hazardous (classified) locations shall be intrinsically safe, approved for the hazardous (classified) location, or safe for the hazardous (classified) location. Requirements for each of these options are as follows:

(1) *Intrinsically safe.* Equipment and associated wiring approved as intrinsically safe is permitted in any hazardous (classified) location for which it is approved;

(2) *Approved for the hazardous (classified) location.* (i) Equipment shall be approved not only for the class of location, but also for the ignitable or combustible properties of the specific gas, vapor, dust, or fiber that will be present.

Note to paragraph (c)(2)(i) of this section: NFPA 70, the National Electrical Code, lists or defines hazardous gases, vapors, and dusts by ''Groups'' characterized by their ignitable or combustible properties.

(ii) Equipment shall be marked to show the class, group, and operating temperature or temperature range, based on operation in a 40-degree C ambient, for which it is approved. The temperature marking may not exceed the ignition temperature of the specific gas or vapor to be encountered. However, the following provisions modify this marking requirement for specific equipment:

(A) Equipment of the nonheat-producing type, such as junction boxes, conduit, and fittings, and equipment of the heat-producing type having a maximum temperature not more than 100° C (212° F) need not have a marked operating temperature or temperature range;

(B) Fixed lighting fixtures marked for use in Class I, Division 2 or Class II, Division 2 locations only need not be marked to indicate the group;

(C) Fixed general-purpose equipment in Class I locations, other than lighting fixtures, that is acceptable for use in Class I, Division 2 locations need not be marked with the class, group, division, or operating temperature;

(D) Fixed dust-tight equipment, other than lighting fixtures, that is acceptable for use in Class II, Division 2 and Class III locations need not be marked with the class, group, division, or operating temperature; and

(E) Electric equipment suitable for ambient temperatures exceeding 40° C (104° F) shall be marked with both the maximum ambient temperature and the operating temperature or temperature range at that ambient temperature; and

(3) *Safe for the hazardous (classified) location.* Equipment that is safe for the location shall be of a type and design that the employer demonstrates will provide protection from the hazards arising from the combustibility and flammability of vapors, liquids, gases, dusts, or fibers involved.

Note to paragraph (c)(3) of this section: The National Electrical Code, NFPA 70, contains guidelines for determining the type and design of equipment and installations that will meet this requirement. Those guidelines address electric wiring, equipment, and systems installed in hazardous (classified) locations and contain specific provisions for the following: wiring methods, wiring connections; conductor insulation, flexible cords, sealing and drainage, transformers, capacitors, switches, circuit breakers, fuses, motor controllers, receptacles, attachment plugs, meters, relays, instruments, resistors, generators, motors, lighting fixtures, storage battery charging equipment, electric cranes, electric hoists and similar equipment, utilization equipment, signaling systems, alarm systems, remote control systems, local loud speaker and communication systems, ventilation piping, live parts, lightning surge protection, and grounding.

(d) *Conduits.* All conduits shall be threaded and shall be made wrench-tight. Where it is impractical to make a threaded joint tight, a bonding jumper shall be utilized.

(e) *Equipment in Division 2 locations.* Equipment that has been approved for a Division 1 location may be installed in a Division 2 location of the same class and group. General-purpose equipment or equipment in general-purpose enclosures may be installed in Division 2 locations if the employer can demonstrate that the equipment does not constitute a source of ignition under normal operating conditions.

(f) *Protection techniques.* The following are acceptable protection techniques for electric and electronic equipment in hazardous (classified) locations.

(1) *Explosionproof apparatus.* This protection technique is permitted for equipment in the Class I, Division 1 and 2 locations for which it is approved.

(2) *Dust ignitionproof.* This protection technique is permitted for equipment in

the Class II, Division 1 and 2 locations for which it is approved.

(3) *Dust-tight.* This protection technique is permitted for equipment in the Class II, Division 2 and Class III locations for which it is approved.

(4) *Purged and pressurized.* This protection technique is permitted for equipment in any hazardous (classified) location for which it is approved.

(5) *Nonincendive circuit.* This protection technique is permitted for equipment in Class I, Division 2; Class II, Division 2; or Class III, Division 1or 2 locations.

(6) *Nonincendive equipment.* This protection technique is permitted for equipment in Class I, Division 2; Class II, Division 2; or Class III, Division 1 or 2 locations.

(7) *Nonincendive component.* This protection technique is permitted for equipment in Class I, Division 2; Class II, Division 2; or Class III, Division 1 or 2 locations.

(8) *Oil immersion.* This protection technique is permitted for current-interrupting contacts in Class I, Division 2 locations as described in the Subpart.

(9) *Hermetically sealed.* This protection technique is permitted for equipment in Class I, Division 2; Class II, Division 2; and Class III, Division 1 or 2 locations.

(10) *Other protection techniques.* Any other protection technique that meets paragraph (c) of this section is acceptable in any hazardous (classified) location.

(g) *Class I, Zone 0, 1, and 2 locations*—(1) *Scope.* Employers may use the zone classification system as an alternative to the division classification system for electric and electronic equipment and wiring for all voltage in Class I, Zone 0, Zone 1, and Zone 2 hazardous (classified) locations where fire or explosion hazards may exist due to flammable gases, vapors, or liquids.

(2) *Location and general requirements.* (i) Locations shall be classified depending on the properties of the flammable vapors, liquids, or gases that may be present and the likelihood that a flammable or combustible concentration or quantity is present. Where pyrophoric materials are the only materials used or handled, these locations need not be classified.

(ii) Each room, section, or area shall be considered individually in determining its classification.

(iii) All threaded conduit shall be threaded with an NPT (National (American) Standard Pipe Taper) standard conduit cutting die that provides ¾-in. taper per foot. The conduit shall be made wrench tight to prevent sparking when fault current flows through the conduit system and to ensure the explosionproof or flameproof integrity of the conduit system where applicable.

(iv) Equipment provided with threaded entries for field wiring connection shall be installed in accordance with paragraph (g)(2)(iv)(A) or (g)(2)(iv)(B) of this section.

(A) For equipment provided with threaded entries for NPT threaded conduit or fittings, listed conduit, conduit fittings, or cable fittings shall be used.

(B) For equipment with metric threaded entries, such entries shall be identified as being metric, or listed adaptors to permit connection to conduit of NPT-threaded fittings shall be provided with the equipment. Adapters shall be used for connection to conduit or NPT-threaded fittings.

(3) *Protection techniques.* One or more of the following protection techniques shall be used for electric and electronic equipment in hazardous (classified) locations classified under the zone classification system.

(i) Flameproof ''d''—This protection technique is permitted for equipment in the Class I, Zone 1 locations for which it is approved.

(ii) Purged and pressurized—This protection technique is permitted for equipment in the Class I, Zone 1 or Zone 2 locations for which it is approved.

(iii) Intrinsic safety—This protection technique is permitted for equipment in the Class I, Zone 0 or Zone 1 locations for which it is approved.

(iv) Type of protection ''n''—This protection technique is permitted for equipment in the Class I, Zone 2 locations for which it is approved. Type of protection ''n'' is further subdivided into nA, nC, and nR.

(v) Oil Immersion ''o''—This protection technique is permitted for equipment in the Class I, Zone 1 locations for which it is approved.

(vi) Increased safety ''e''—This protection technique is permitted for equipment in the Class I, Zone 1 locations for which it is approved.

(vii) Encapsulation ''m''—This protection technique is permitted for equipment in the Class I, Zone 1 locations for which it is approved.

(viii) Powder Filling ''q''—This protection technique is permitted for equipment in the Class I, Zone 1 locations for which it is approved.

(4) *Special precaution.* Paragraph (g) of this section requires equipment construction and installation that will ensure safe performance under conditions of proper use and maintenance.

(i) Classification of areas and selection of equipment and wiring methods shall be under the supervision of a qualified registered professional engineer.

(ii) In instances of areas within the same facility classified separately, Class I, Zone 2 locations may abut, but not overlap, Class I, Division 2 locations. Class I, Zone 0 or Zone 1 locations may not abut Class I, Division 1 or Division 2 locations.

(iii) A Class I, Division 1 or Division 2 location may be reclassified as a Class I, Zone 0, Zone 1, or Zone 2 location only if all of the space that is classified because of a single flammable gas or vapor source is reclassified.

Note to paragraph (g)(4) of this section: Low ambient conditions require special consideration. Electric equipment depending on the protection techniques described by paragraph (g)(3)(i) of this section may not be suitable for use at temperatures lower than −20 °C (−4 °F) unless they are approved for use at lower temperatures. However, at low ambient temperatures, flammable concentrations of vapors may not exist in a location classified Class I, Zone 0, 1, or 2 at normal ambient temperature.

(5) *Listing and marking.* (i) Equipment that is listed for a Zone 0 location may be installed in a Zone 1 or Zone 2 location of the same gas or vapor. Equipment that is listed for a Zone 1 location may be installed in a Zone 2 location of the same gas or vapor.

(ii) Equipment shall be marked in accordance with paragraph (g)(5)(ii)(A) and (g)(5)(ii)(B) of this section, except as provided in (g)(5)(ii)(C).

(A) Equipment approved for Class I, Division 1 or Class 1, Division 2 shall, in addition to being marked in accordance with (c)(2)(ii), be marked with the following:

(1) Class I, Zone 1 or Class I, Zone 2 (as applicable);

(2) Applicable gas classification groups; and

(3) Temperature classification; or

(B) Equipment meeting one or more of the protection techniques described in paragraph (g)(3) of this section shall be marked with the following in the order shown:

(1) Class, except for intrinsically safe apparatus;

(2) Zone, except for intrinsically safe apparatus;

(3) Symbol ''AEx;''

(4) Protection techniques;

(5) Applicable gas classification groups; and

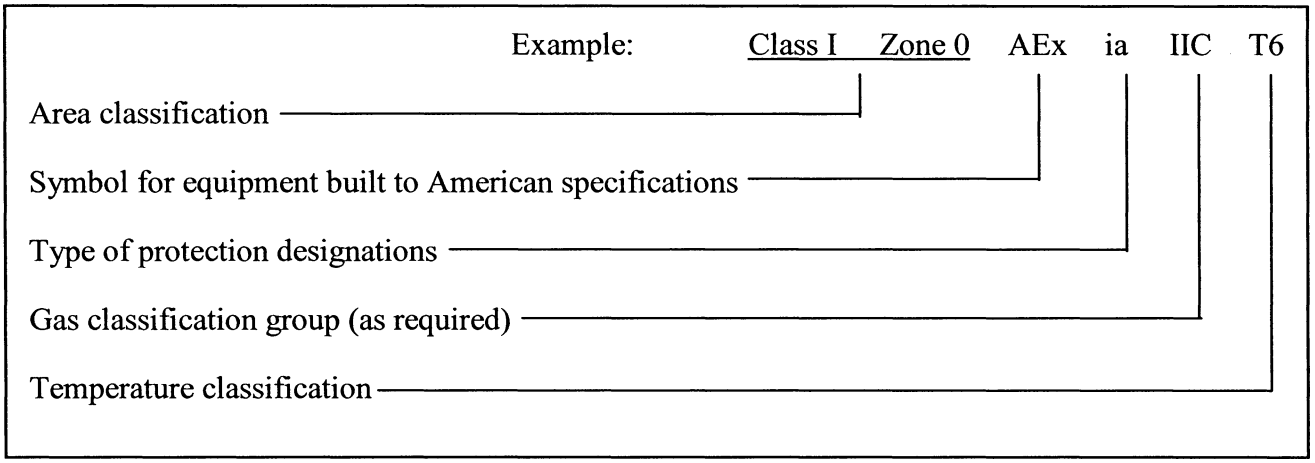
(6) Temperature classification, except for intrinsically safe apparatus.

Note to paragraph (g)(5)(ii)(B) of this section: An example of such a required marking is ''Class I, Zone 0, AEx ia IIC T6.'' See Figure S–1 for an explanation of this marking.

(C) Equipment that the employer demonstrates will provide protection from the hazards arising from the flammability of the gas or vapor and the zone of location involved and will be recognized as providing such protection by employees need not be marked.

Note to paragraph (g)(5)(ii)(C) of this section: The National Electrical Code, NFPA 70, contains guidelines for determining the type and design of equipment and installations that will meet this provision.

Figure S-1—Example Marking for Class I, Zone 0, AEx ia IIC T6



§ 1910.308 Special systems.

(a) *Systems over 600 volts, nominal.* This paragraph covers the general requirements for all circuits and equipment operated at over 600 volts.

(1) *Aboveground wiring methods.* (i) Aboveground conductors shall be installed in rigid metal conduit, in intermediate metal conduit, in electrical metallic tubing, in rigid nonmetallic conduit, in cable trays, as busways, as cablebus, in other identified raceways, or as open runs of metal-clad cable suitable for the use and purpose. In locations accessible to qualified persons only, open runs of Type MV cables, bare conductors, and bare busbars are also permitted. Busbars shall be either copper or aluminum. Open runs of insulated wires and cables having a bare lead sheath or a braided outer covering shall be supported in a manner designed to prevent physical damage to the braid or sheath.

(ii) Conductors emerging from the ground shall be enclosed in approved raceways.

(2) *Braid-covered insulated conductors—open installations.* The braid on open runs of braid-covered insulated conductors shall be flame retardant or shall have a flame-retardant saturant applied after installation. This treated braid covering shall be stripped back a safe distance at conductor terminals, according to the operating voltage.

(3) *Insulation shielding.* (i) Metallic and semiconductor insulation shielding components of shielded cables shall be removed for a distance dependent on the circuit voltage and insulation. Stress reduction means shall be provided at all terminations of factory-applied shielding.

(ii) Metallic shielding components such as tapes, wires, or braids, or combinations thereof, and their associated conducting and semiconducting components shall be grounded.

(4) *Moisture or mechanical protection for metal-sheathed cables.* Where cable conductors emerge from a metal sheath and where protection against moisture or physical damage is necessary, the insulation of the conductors shall be protected by a cable sheath terminating device.

(5) *Interrupting and isolating devices.* (i) Circuit breaker installations located indoors shall consist of metal-enclosed units or fire-resistant cell-mounted units. In locations accessible only to qualified employees, open mounting of circuit breakers is permitted. A means of indicating the open and closed position of circuit breakers shall be provided.

(ii) Where fuses are used to protect conductors and equipment, a fuse shall be placed in each ungrounded conductor. Two power fuses may be used in parallel to protect the same load, if both fuses have identical ratings, and if both fuses are installed in an identified common mounting with electrical connections that will divide the current equally. Power fuses of the vented type may not be used indoors, underground, or in metal enclosures unless identified for the use.

(iii) Fused cutouts installed in buildings or transformer vaults shall be of a type identified for the purpose. Distribution cutouts may not be used indoors, underground, or in metal enclosures. They shall be readily accessible for fuse replacement.

(iv) Where fused cutouts are not suitable to interrupt the circuit manually while carrying full load, an approved means shall be installed to interrupt the entire load. Unless the fused cutouts are interlocked with the switch to prevent opening of the cutouts under load, a conspicuous sign shall be placed at such cutouts reading: ''WARNING—DO NOT OPERATE UNDER LOAD.''

(v) Suitable barriers or enclosures shall be provided to prevent contact with nonshielded cables or energized parts of oil-filled cutouts.

(vi) Load interrupter switches may be used only if suitable fuses or circuits are used in conjunction with these devices to interrupt fault currents.

(A) Where these devices are used in combination, they shall be coordinated electrically so that they will safely withstand the effects of closing, carrying, or interrupting all possible currents up to the assigned maximum short-circuit rating.

(B) Where more than one switch is installed with interconnected load terminals to provide for alternate connection to different supply conductors, each switch shall be provided with a conspicuous sign reading: ''WARNING—SWITCH MAY BE ENERGIZED BY BACKFEED.''

(vii) A means (for example, a fuseholder and fuse designed for the purpose) shall be provided to completely isolate equipment for inspection and repairs. Isolating means that are not designed to interrupt the load current of the circuit shall be either interlocked with an approved circuit interrupter or provided with a sign warning against opening them under load.

(6) *Mobile and portable equipment.* (i) A metallic enclosure shall be provided on the mobile machine for enclosing the terminals of the power cable. The enclosure shall include provisions for a solid connection for the grounding terminal to effectively ground the machine frame. The method of cable termination used shall prevent any strain or pull on the cable from stressing the electrical connections. The enclosure shall have provision for locking so only authorized qualified persons may open it and shall be marked with a sign warning of the presence of energized parts.

(ii) All energized switching and control parts shall be enclosed in effectively grounded metal cabinets or enclosures. Circuit breakers and protective equipment shall have the operating means projecting through the metal cabinet or enclosure so these units can be reset without locked doors being opened. Enclosures and metal cabinets shall be locked so that only authorized qualified persons have access and shall be marked with a sign warning of the presence of energized parts. Collector ring assemblies on revolving-type machines (shovels, draglines, etc.) shall be guarded.

(7) *Tunnel installations.* This paragraph applies to installation and use of high-voltage power distribution and utilization equipment that is portable or mobile, such as substations, trailers, cars, mobile shovels, draglines, hoists, drills, dredges, compressors, pumps, conveyors, and underground excavators.

(i) Conductors in tunnels shall be installed in one or more of the following:

(A) Metal conduit or other metal raceway;

(B) Type MC cable; or

(C) Other approved multiconductor cable.

(ii) Multiconductor portable cable may supply mobile equipment.

(iii) Conductors and cables shall also be so located or guarded as to protect them from physical damage. An equipment grounding conductor shall be run with circuit conductors inside the metal raceway or inside the multiconductor cable jacket. The equipment grounding conductor may be insulated or bare.

(iv) Bare terminals of transformers, switches, motor controllers, and other equipment shall be enclosed to prevent accidental contact with energized parts.

(v) Enclosures for use in tunnels shall be drip-proof, weatherproof, or submersible as required by the environmental conditions.

(vi) Switch or contactor enclosures may not be used as junction boxes or raceways for conductors feeding through or tapping off to other switches, unless special designs are used to provide adequate space for this purpose.

(vii) A disconnecting means that simultaneously opens all ungrounded conductors shall be installed at each transformer or motor location.

(viii) All nonenergized metal parts of electric equipment and metal raceways and cable sheaths shall be effectively grounded and bonded to all metal pipes and rails at the portal and at intervals not exceeding 305 m (1000 ft) throughout the tunnel.

(b) *Emergency power systems.* This paragraph applies to circuits, systems, and equipment intended to supply power for illumination and special loads in the event of failure of the normal supply.

(1) *Wiring methods.* Emergency circuit wiring shall be kept entirely independent of all other wiring and equipment and may not enter the same raceway, cable, box, or cabinet or other wiring except either where common circuit elements suitable for the purpose are required, or for transferring power from the normal to the emergency source.

(2) *Emergency illumination.* Emergency illumination shall include all required means of egress lighting, illuminated exit signs, and all other lights necessary to provide illumination. Where emergency lighting is necessary, the system shall be so arranged that the failure of any individual lighting element, such as the burning out of a light bulb, cannot leave any space in total darkness.

(3) *Signs.* (i) A sign shall be placed at the service entrance equipment indicating the type and location of on-site emergency power sources. However, a sign is not required for individual unit equipment.

(ii) Where the grounded circuit conductor connected to the emergency source is connected to a grounding electrode conductor at a location remote from the emergency source, there shall be a sign at the grounding location that shall identify all emergency and normal sources connected at that location.

(c) *Class 1, Class 2, and Class 3 remote control, signaling, and power-limited circuits*—(1) *Classification.* Class 1, Class 2, and Class 3 remote control, signaling, or power-limited circuits are characterized by their usage and electrical power limitation that differentiates them from light and power circuits. These circuits are classified in accordance with their respective voltage and power limitations as summarized in paragraphs (c)(1)(i) through (c)(1)(iii) of this section.

(i) A Class 1 power-limited circuit shall be supplied from a source having a rated output of not more than 30 volts and 1000 volt-amperes.

(ii) A Class 1 remote control circuit or a Class 1 signaling circuit shall have a voltage not exceeding 600 volts; however, the power output of the source need not be limited.

(iii) The power source for a Class 2 or Class 3 circuit shall be listed equipment marked as a Class 2 or Class 3 power source, except as follows:

(A) Thermocouples do not require listing as a Class 2 power source; and

(B) A dry cell battery is considered an inherently limited Class 2 power source, provided the voltage is 30 volts or less and the capacity is less than or equal to that available from series-connected No. 6 carbon zinc cells.

(2) *Marking.* A Class 2 or Class 3 power supply unit shall be durably marked where plainly visible to indicate the class of supply and its electrical rating.

(3) *Separation from conductors of other circuits.* Cables and conductors of Class 2 and Class 3 circuits may not be placed in any cable, cable tray, compartment, enclosure, manhole, outlet box, device box, raceway, or similar fitting with conductors of electric light, power, Class 1, nonpower-limited fire alarm circuits, and medium power network-powered broadband communications cables unless a barrier or other equivalent form of protection against contact is employed.

(d) *Fire alarm systems*—(1) *Classifications.* Fire alarm circuits shall be classified either as nonpower limited or power limited.

(2) *Power sources.* The power sources for use with fire alarm circuits shall be either power limited or nonpower limited as follows:

(i) The power source of nonpower-limited fire alarm (NPLFA) circuits shall have an output voltage of not more than 600 volts, nominal; and

(ii) The power source for a power-limited fire alarm (PLFA) circuit shall be listed equipment marked as a PLFA power source.

(3) *Separation from conductors of other circuits.* (i) Nonpower-limited fire alarm circuits and Class 1 circuits may occupy the same enclosure, cable, or raceway provided all conductors are insulated for maximum voltage of any conductor within the enclosure, cable, or raceway. Power supply and fire alarm circuit conductors are permitted in the same enclosure, cable, or raceway only if connected to the same equipment.

(ii) Power-limited circuit cables and conductors may not be placed in any cable, cable tray, compartment, enclosure, outlet box, raceway, or similar fitting with conductors of electric light, power, Class 1, nonpower-limited fire alarm circuit conductors, or medium power network-powered broadband communications circuits.

(iii) Power-limited fire alarm circuit conductors shall be separated at least 50.8 mm (2 in.) from conductors of any electric light, power, Class 1, nonpower-limited fire alarm, or medium power network-powered broadband communications circuits unless a special and equally protective method of conductor separation is employed.

(iv) Conductors of one or more Class 2 circuits are permitted within the same cable, enclosure, or raceway with conductors of power-limited fire alarm circuits provided that the insulation of Class 2 circuit conductors in the cable, enclosure, or raceway is at least that needed for the power-limited fire alarm circuits.

(4) *Identification.* Fire alarm circuits shall be identified at terminal and junction locations in a manner that will prevent unintentional interference with the signaling circuit during testing and servicing. Power-limited fire alarm circuits shall be durably marked as such where plainly visible at terminations.

(e) *Communications systems.* This paragraph applies to central-station-connected and non-central-station-connected telephone circuits, radio and television receiving and transmitting equipment, including community antenna television and radio distribution systems, telegraph, district messenger, and outside wiring for fire and burglar alarm, and similar central station systems. These installations need not comply with the provisions of § 1910.303 through § 1910.308(d), except for § 1910.304(c)(1) and § 1910.307.

(1) *Protective devices.* (i) A listed primary protector shall be provided on each circuit run partly or entirely in aerial wire or aerial cable not confined within a block.

(ii) A listed primary protector shall be also provided on each aerial or underground circuit when the location of the circuit within the block containing the building served allows the circuit to be exposed to accidental contact with electric light or power conductors operating at over 300 volts to ground.

(iii) In addition, where there exists a lightning exposure, each interbuilding circuit on premises shall be protected by a listed primary protector at each end of the interbuilding circuit.

(2) *Conductor location.* (i) Lead-in or aerial-drop cables from a pole or other support, including the point of initial attachment to a building or structure, shall be kept away from electric light, power, Class 1, or nonpower-limited fire alarm circuit conductors so as to avoid the possibility of accidental contact.

(ii) A separation of at least 1.83 m (6 ft) shall be maintained between communications wires and cables on buildings and lightning conductors.

(iii) Where communications wires and cables and electric light or power conductors are supported by the same pole or run parallel to each other in-span, the following conditions shall be met:

(A) Where practicable, communication wires and cables on poles shall be located below the electric light or power conductors; and

(B) Communications wires and cables may not be attached to a crossarm that carries electric light or power conductors.

(iv) Indoor communications wires and cables shall be separated at least 50.8 mm (2 in.) from conductors of any electric light, power, Class 1, nonpower-limited fire alarm, or medium power network-powered broadband communications circuits, unless a special and equally protective method of conductor separation, identified for the purpose, is employed.

(3) *Equipment location.* Outdoor metal structures supporting antennas, as well as self-supporting antennas such as vertical rods or dipole structures, shall be located as far away from overhead conductors of electric light and power circuits of over 150 volts to ground as necessary to prevent the antenna or structure from falling into or making accidental contact with such circuits.

(4) *Grounding.* (i) If exposed to contact with electric light and power conductors, the metal sheath of aerial cables entering buildings shall be grounded or shall be interrupted close to the entrance to the building by an insulating joint or equivalent device. Where protective devices are used, they shall be grounded in an approved manner.

(ii) Masts and metal structures supporting antennas shall be permanently and effectively grounded without splice or connection in the grounding conductor.

(iii) Transmitters shall be enclosed in a metal frame or grill or separated from the operating space by a barrier, all metallic parts of which are effectively connected to ground. All external metal handles and controls accessible to the operating personnel shall be effectively grounded. Unpowered equipment and enclosures are considered to be grounded where connected to an attached coaxial cable with an effectively grounded metallic shield.

(f) *Solar photovoltaic systems.* This paragraph covers solar photovoltaic systems that can be interactive with other electric power production sources or can stand alone with or without electrical energy storage such as batteries. These systems may have ac or dc output for utilization.

(1) *Conductors of different systems.* Photovoltaic source circuits and photovoltaic output circuits may not be contained in the same raceway, cable tray, cable, outlet box, junction box, or similar fitting as feeders or branch circuits of other systems, unless the conductors of the different systems are separated by a partition or are connected together.

(2) *Disconnecting means.* Means shall be provided to disconnect all current-carrying conductors of a photovoltaic power source from all other conductors in a building or other structure. Where a circuit grounding connection is not designed to be automatically interrupted as part of the ground-fault protection system, a switch or circuit breaker used as disconnecting means may not have a pole in the grounded conductor.

(g) *Integrated electrical systems*—(1) *Scope.* Paragraph (g) of this section covers integrated electrical systems, other than unit equipment, in which orderly shutdown is necessary to ensure safe operation. An integrated electrical system as used in this section shall be a unitized segment of an industrial wiring system where all of the following conditions are met:

(i) An orderly shutdown process minimizes employee hazard and equipment damage;

(ii) The conditions of maintenance and supervision ensure that only qualified persons will service the system; and

(iii) Effective safeguards are established and maintained.

(2) *Location of overcurrent devices in or on premises.* Overcurrent devices that are critical to integrated electrical systems need not be readily accessible to employees as required by § 1910.304(f)(1)(iv) if they are located

with mounting heights to ensure security from operation by nonqualified persons.

■ 7. Section 1910.399 is revised to read as follows:

§ 1910.399 Definitions applicable to this subpart.

Acceptable. An installation or equipment is acceptable to the Assistant Secretary of Labor, and approved within the meaning of this Subpart S:

(1) If it is accepted, or certified, or listed, or labeled, or otherwise determined to be safe by a nationally recognized testing laboratory recognized pursuant to § 1910.7; or

(2) With respect to an installation or equipment of a kind that no nationally recognized testing laboratory accepts, certifies, lists, labels, or determines to be safe, if it is inspected or tested by another Federal agency, or by a State, municipal, or other local authority responsible for enforcing occupational safety provisions of the National Electrical Code, and found in compliance with the provisions of the National Electrical Code as applied in this subpart; or

(3) With respect to custom-made equipment or related installations that are designed, fabricated for, and intended for use by a particular customer, if it is determined to be safe for its intended use by its manufacturer on the basis of test data which the employer keeps and makes available for inspection to the Assistant Secretary and his authorized representatives.

Accepted. An installation is ''accepted'' if it has been inspected and found by a nationally recognized testing laboratory to conform to specified plans or to procedures of applicable codes.

Accessible. (As applied to wiring methods.) Capable of being removed or exposed without damaging the building structure or finish, or not permanently closed in by the structure or finish of the building. (See ''concealed'' and ''exposed.'')

Accessible. (As applied to equipment.) Admitting close approach; not guarded by locked doors, elevation, or other effective means. (See ''Readily accessible.'')

Ampacity. The current, in amperes, that a conductor can carry continuously under the conditions of use without exceeding its temperature rating.

Appliances. Utilization equipment, generally other than industrial, normally built in standardized sizes or types, that is installed or connected as a unit to perform one or more functions.

Approved. Acceptable to the authority enforcing this subpart. The authority enforcing this subpart is the Assistant Secretary of Labor for Occupational Safety and Health. The definition of ''acceptable'' indicates what is acceptable to the Assistant Secretary of Labor, and therefore approved within the meaning of this subpart.

Armored cable (Type AC). A fabricated assembly of insulated conductors in a flexible metallic enclosure.

Askarel. A generic term for a group of nonflammable synthetic chlorinated hydrocarbons used as electrical insulating media. Askarels of various compositional types are used. Under arcing conditions, the gases produced, while consisting predominantly of noncombustible hydrogen chloride, can include varying amounts of combustible gases depending upon the askarel type.

Attachment plug (Plug cap)(Cap). A device that, by insertion in a receptacle, establishes a connection between the conductors of the attached flexible cord and the conductors connected permanently to the receptacle.

Automatic. Self-acting, operating by its own mechanism when actuated by some impersonal influence, as, for example, a change in current strength, pressure, temperature, or mechanical configuration.

Bare conductor. See Conductor.

Barrier. A physical obstruction that is intended to prevent contact with equipment or live parts or to prevent unauthorized access to a work area.

Bathroom. An area including a basin with one or more of the following: a toilet, a tub, or a shower.

Bonding (Bonded). The permanent joining of metallic parts to form an electrically conductive path that ensures electrical continuity and the capacity to conduct safely any current likely to be imposed.

Bonding jumper. A conductor that assures the necessary electrical conductivity between metal parts required to be electrically connected.

Branch circuit. The circuit conductors between the final overcurrent device protecting the circuit and the outlets.

Building. A structure that stands alone or is cut off from adjoining structures by fire walls with all openings therein protected by approved fire doors.

Cabinet. An enclosure designed either for surface or flush mounting, and provided with a frame, mat, or trim in which a swinging door or doors are or can be hung.

Cable tray system. A unit or assembly of units or sections and associated fittings forming a rigid structural system used to securely fasten or support cables and raceways. Cable tray systems include ladders, troughs, channels, solid bottom trays, and other similar structures.

Cablebus. An assembly of insulated conductors with fittings and conductor terminations in a completely enclosed, ventilated, protective metal housing.

Cell line. An assembly of electrically interconnected electrolytic cells supplied by a source of direct current power.

Cell line attachments and auxiliary equipment. Cell line attachments and auxiliary equipment include, but are not limited to, auxiliary tanks, process piping, ductwork, structural supports, exposed cell line conductors, conduits and other raceways, pumps, positioning equipment, and cell cutout or bypass electrical devices. Auxiliary equipment also includes tools, welding machines, crucibles, and other portable equipment used for operation and maintenance within the electrolytic cell line working zone. In the cell line working zone, auxiliary equipment includes the exposed conductive surfaces of ungrounded cranes and crane-mounted cell-servicing equipment.

Center pivot irrigation machine. A multi-motored irrigation machine that revolves around a central pivot and employs alignment switches or similar devices to control individual motors.

Certified. Equipment is ''certified'' if it bears a label, tag, or other record of certification that the equipment:

(1) Has been tested and found by a nationally recognized testing laboratory to meet nationally recognized standards or to be safe for use in a specified manner; or

(2) Is of a kind whose production is periodically inspected by a nationally recognized testing laboratory and is accepted by the laboratory as safe for its intended use.

Circuit breaker. A device designed to open and close a circuit by nonautomatic means and to open the circuit automatically on a predetermined overcurrent without damage to itself when properly applied within its rating.

Class I locations. Class I locations are those in which flammable gases or vapors are or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures. Class I locations include the following:

(1) *Class I, Division 1.* A Class I, Division 1 location is a location:

(i) In which ignitable concentrations of flammable gases or vapors may exist under normal operating conditions; or

(ii) In which ignitable concentrations of such gases or vapors may exist frequently because of repair or maintenance operations or because of leakage; or

(iii) In which breakdown or faulty operation of equipment or processes might release ignitable concentrations of flammable gases or vapors, and might also cause simultaneous failure of electric equipment.

Note to the definition of ''Class I, Division 1:'' This classification usually includes locations where volatile flammable liquids or liquefied flammable gases are transferred from one container to another; interiors of spray booths and areas in the vicinity of spraying and painting operations where volatile flammable solvents are used; locations containing open tanks or vats of volatile flammable liquids; drying rooms or compartments for the evaporation of flammable solvents; locations containing fat and oil extraction equipment using volatile flammable solvents; portions of cleaning and dyeing plants where flammable liquids are used; gas generator rooms and other portions of gas manufacturing plants where flammable gas may escape; inadequately ventilated pump rooms for flammable gas or for volatile flammable liquids; the interiors of refrigerators and freezers in which volatile flammable materials are stored in open, lightly stoppered, or easily ruptured containers; and all other locations where ignitable concentrations of flammable vapors or gases are likely to occur in the course of normal operations.

(2) *Class I, Division 2.* A Class I, Division 2 location is a location:

(i) In which volatile flammable liquids or flammable gases are handled, processed, or used, but in which the hazardous liquids, vapors, or gases will normally be confined within closed containers or closed systems from which they can escape only in the event of accidental rupture or breakdown of such containers or systems, or as a result of abnormal operation of equipment; or

(ii) In which ignitable concentrations of gases or vapors are normally prevented by positive mechanical ventilation, and which might become hazardous through failure or abnormal operations of the ventilating equipment; or

(iii) That is adjacent to a Class I, Division 1 location, and to which ignitable concentrations of gases or vapors might occasionally be communicated unless such communication is prevented by adequate positive-pressure ventilation from a source of clean air, and effective safeguards against ventilation failure are provided.

Note to the definition of ''Class I, Division 2:'' This classification usually includes locations where volatile flammable liquids or flammable gases or vapors are used, but which would become hazardous only in case of an accident or of some unusual operating condition. The quantity of flammable material that might escape in case of accident, the adequacy of ventilating equipment, the total area involved, and the record of the industry or business with respect to explosions or fires are all factors that merit consideration in determining the classification and extent of each location.

Piping without valves, checks, meters, and similar devices would not ordinarily introduce a hazardous condition even though used for flammable liquids or gases. Locations used for the storage of flammable liquids or liquefied or compressed gases in sealed containers would not normally be considered hazardous unless also subject to other hazardous conditions.

Electrical conduits and their associated enclosures separated from process fluids by a single seal or barrier are classed as a Division 2 location if the outside of the conduit and enclosures is a nonhazardous location.

(3) *Class I, Zone 0.* A Class I, Zone 0 location is a location in which one of the following conditions exists:

(i) Ignitable concentrations of flammable gases or vapors are present continuously; or

(ii) Ignitable concentrations of flammable gases or vapors are present for long periods of time.

Note to the definition of ''Class I, Zone 0:'' As a guide in determining when flammable gases or vapors are present continuously or for long periods of time, refer to *Recommended Practice for Classification of Locations for Electrical Installations of Petroleum Facilities Classified as Class I, Zone 0, Zone 1 or Zone 2,* API RP 505–1997; *Electrical Apparatus for Explosive Gas Atmospheres, Classifications of Hazardous Areas,* IEC 79–10–1995; *Area Classification Code for Petroleum Installations, Model Code—Part 15,* Institute for Petroleum; and *Electrical Apparatus for Explosive Gas Atmospheres, Classifications of Hazardous (Classified) Locations,* ISA S12.24.01–1997.

(4) *Class I, Zone 1.* A Class I, Zone 1 location is a location in which one of the following conditions exists:

(i) Ignitable concentrations of flammable gases or vapors are likely to exist under normal operating conditions; or

(ii) Ignitable concentrations of flammable gases or vapors may exist frequently because of repair or maintenance operations or because of leakage; or

(iii) Equipment is operated or processes are carried on of such a nature that equipment breakdown or faulty operations could result in the release of ignitable concentrations of flammable gases or vapors and also cause simultaneous failure of electric equipment in a manner that would cause the electric equipment to become a source of ignition; or

(iv) A location that is adjacent to a Class I, Zone 0 location from which ignitable concentrations of vapors could be communicated, unless communication is prevented by adequate positive pressure ventilation from a source of clean air and effective safeguards against ventilation failure are provided.

(5) *Class I, Zone 2.* A Class I, Zone 2 location is a location in which one of the following conditions exists:

(i) Ignitable concentrations of flammable gases or vapors are not likely to occur in normal operation and if they do occur will exist only for a short period; or

(ii) Volatile flammable liquids, flammable gases, or flammable vapors are handled, processed, or used, but in which the liquids, gases, or vapors are normally confined within closed containers or closed systems from which they can escape only as a result of accidental rupture or breakdown of the containers or system or as the result of the abnormal operation of the equipment with which the liquids or gases are handled, processed, or used; or

(iii) Ignitable concentrations of flammable gases or vapors normally are prevented by positive mechanical ventilation, but which may become hazardous as the result of failure or abnormal operation of the ventilation equipment; or

(iv) A location that is adjacent to a Class I, Zone 1 location, from which ignitable concentrations of flammable gases or vapors could be communicated, unless such communication is prevented by adequate positive-pressure ventilation from a source of clean air, and effective safeguards against ventilation failure are provided.

Class II locations. Class II locations are those that are hazardous because of the presence of combustible dust. Class II locations include the following:

(1) *Class II, Division 1.* A Class II, Division 1 location is a location:

(i) In which combustible dust is or may be in suspension in the air under normal operating conditions, in quantities sufficient to produce explosive or ignitable mixtures; or

(ii) Where mechanical failure or abnormal operation of machinery or equipment might cause such explosive or ignitable mixtures to be produced, and might also provide a source of ignition through simultaneous failure of electric equipment, through operation of protection devices, or from other causes; or

(iii) In which combustible dusts of an electrically conductive nature may be present.

Note to the definition of ''Class II, Division 1:'' This classification may include areas of grain handling and processing plants, starch plants, sugar-pulverizing plants, malting

plants, hay-grinding plants, coal pulverizing plants, areas where metal dusts and powders are produced or processed, and other similar locations that contain dust producing machinery and equipment (except where the equipment is dust-tight or vented to the outside). These areas would have combustible dust in the air, under normal operating conditions, in quantities sufficient to produce explosive or ignitable mixtures. Combustible dusts that are electrically nonconductive include dusts produced in the handling and processing of grain and grain products, pulverized sugar and cocoa, dried egg and milk powders, pulverized spices, starch and pastes, potato and wood flour, oil meal from beans and seed, dried hay, and other organic materials which may produce combustible dusts when processed or handled. Dusts containing magnesium or aluminum are particularly hazardous, and the use of extreme caution is necessary to avoid ignition and explosion.

(2) *Class II, Division 2.* A Class II, Division 2 location is a location where:

(i) Combustible dust will not normally be in suspension in the air in quantities sufficient to produce explosive or ignitable mixtures, and dust accumulations will normally be insufficient to interfere with the normal operation of electric equipment or other apparatus, but combustible dust may be in suspension in the air as a result of infrequent malfunctioning of handling or processing equipment; and

(ii) Resulting combustible dust accumulations on, in, or in the vicinity of the electric equipment may be sufficient to interfere with the safe dissipation of heat from electric equipment or may be ignitable by abnormal operation or failure of electric equipment.

Note to the definition of ''Class II, Division 2:'' This classification includes locations where dangerous concentrations of suspended dust would not be likely, but where dust accumulations might form on or in the vicinity of electric equipment. These areas may contain equipment from which appreciable quantities of dust would escape under abnormal operating conditions or be adjacent to a Class II Division 1 location, as described above, into which an explosive or ignitable concentration of dust may be put into suspension under abnormal operating conditions.

Class III locations. Class III locations are those that are hazardous because of the presence of easily ignitable fibers or flyings, but in which such fibers or flyings are not likely to be in suspension in the air in quantities sufficient to produce ignitable mixtures. Class III locations include the following:

(1) *Class III, Division 1.* A Class III, Division 1 location is a location in which easily ignitable fibers or materials producing combustible flyings are handled, manufactured, or used.

Note to the definition of ''Class III, Division 1:'' Such locations usually include some parts of rayon, cotton, and other textile mills; combustible fiber manufacturing and processing plants; cotton gins and cotton-seed mills; flax-processing plants; clothing manufacturing plants; woodworking plants, and establishments; and industries involving similar hazardous processes or conditions.

Easily ignitable fibers and flyings include rayon, cotton (including cotton linters and cotton waste), sisal or henequen, istle, jute, hemp, tow, cocoa fiber, oakum, baled waste kapok, Spanish moss, excelsior, and other materials of similar nature.

(2) *Class III, Division 2.* A Class III, Division 2 location is a location in which easily ignitable fibers are stored or handled, other than in the process of manufacture.

Collector ring. An assembly of slip rings for transferring electric energy from a stationary to a rotating member.

Competent Person. One who is capable of identifying existing and predictable hazards in the surroundings or working conditions that are unsanitary, hazardous, or dangerous to employees and who has authorization to take prompt corrective measures to eliminate them.

Concealed. Rendered inaccessible by the structure or finish of the building. Wires in concealed raceways are considered concealed, even though they may become accessible by withdrawing them. (See Accessible. (As applied to wiring methods.))

Conductor—(1) *Bare.* A conductor having no covering or electrical insulation whatsoever.

(2) *Covered.* A conductor encased within material of composition or thickness that is not recognized by this subpart as electrical insulation.

(3) *Insulated.* A conductor encased within material of composition and thickness that is recognized by this subpart as electrical insulation.

Conduit body. A separate portion of a conduit or tubing system that provides access through one or more removable covers to the interior of the system at a junction of two or more sections of the system or at a terminal point of the system. Boxes such as FS and FD or larger cast or sheet metal boxes are not classified as conduit bodies.

Controller. A device or group of devices that serves to govern, in some predetermined manner, the electric power delivered to the apparatus to which it is connected.

Covered conductor. See Conductor.

Cutout. (Over 600 volts, nominal.) An assembly of a fuse support with either a fuseholder, fuse carrier, or disconnecting blade. The fuseholder or fuse carrier may include a conducting element (fuse link), or may act as the disconnecting blade by the inclusion of a nonfusible member.

Cutout box. An enclosure designed for surface mounting and having swinging doors or covers secured directly to and telescoping with the walls of the box proper. (See Cabinet.)

Damp location. See Location.

Dead front. Without live parts exposed to a person on the operating side of the equipment

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

Device. A unit of an electrical system that is intended to carry but not utilize electric energy.

Dielectric heating. The heating of a nominally insulating material due to its own dielectric losses when the material is placed in a varying electric field.

Disconnecting means. A device, or group of devices, or other means by which the conductors of a circuit can be disconnected from their source of supply.

Disconnecting (or Isolating) switch. (Over 600 volts, nominal.) A mechanical switching device used for isolating a circuit or equipment from a source of power.

Electrolytic cell line working zone. The cell line working zone is the space envelope wherein operation or maintenance is normally performed on or in the vicinity of exposed energized surfaces of electrolytic cell lines or their attachments.

Electrolytic cells. A tank or vat in which electrochemical reactions are caused by applying energy for the purpose of refining or producing usable materials.

Enclosed. Surrounded by a case, housing, fence, or walls that will prevent persons from accidentally contacting energized parts.

Enclosure. The case or housing of apparatus, or the fence or walls surrounding an installation to prevent personnel from accidentally contacting energized parts, or to protect the equipment from physical damage.

Energized. Electrically connected to a source of potential difference.

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

Equipment grounding conductor. See Grounding conductor, equipment.

Explosion-proof apparatus. Apparatus enclosed in a case that is capable of withstanding an explosion of a specified gas or vapor that may occur within it and of preventing the ignition of a

specified gas or vapor surrounding the enclosure by sparks, flashes, or explosion of the gas or vapor within, and that operates at such an external temperature that it will not ignite a surrounding flammable atmosphere.

Exposed. (As applied to live parts.) Capable of being inadvertently touched or approached nearer than a safe distance by a person. It is applied to parts not suitably guarded, isolated, or insulated. (See Accessible and Concealed.)

Exposed. (As applied to wiring methods.) On or attached to the surface, or behind panels designed to allow access. (See Accessible. (As applied to wiring methods.))

Exposed. (For the purposes of § 1910.308(e).) Where the circuit is in such a position that in case of failure of supports or insulation, contact with another circuit may result.

Externally operable. Capable of being operated without exposing the operator to contact with live parts.

Feeder. All circuit conductors between the service equipment, the source of a separate derived system, or other power supply source and the final branch-circuit overcurrent device.

Fitting. An accessory such as a locknut, bushing, or other part of a wiring system that is intended primarily to perform a mechanical rather than an electrical function.

Fountain. Fountains, ornamental pools, display pools, and reflection pools.

Note to the definition of ''fountain:'' This definition does not include drinking fountains.

Fuse. (Over 600 volts, nominal.) An overcurrent protective device with a circuit opening fusible part that is heated and severed by the passage of overcurrent through it. A fuse comprises all the parts that form a unit capable of performing the prescribed functions. It may or may not be the complete device necessary to connect it into an electrical circuit.

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

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

Grounded, effectively. Intentionally connected to earth through a ground connection or connections of sufficiently low impedance and having sufficient current-carrying capacity to prevent the buildup of voltages that may result in undue hazards to connected equipment or to persons.

Grounded conductor. A system or circuit conductor that is intentionally grounded.

Grounding conductor. A conductor used to connect equipment or the grounded circuit of a wiring system to a grounding electrode or electrodes.

Grounding conductor, equipment. The conductor used to connect the noncurrent-carrying metal parts of equipment, raceways, and other enclosures to the system grounded conductor, the grounding electrode conductor, or both, at the service equipment or at the source of a separately derived system.

Grounding electrode conductor. The conductor used to connect the grounding electrode to the equipment grounding conductor, to the grounded conductor, or to both, of the circuits at the service equipment or at the source of a separately derived system.

Ground-fault circuit-interrupter. A device intended for the protection of personnel that functions to deenergize a circuit or a portion of a circuit within an established period of time when a current to ground exceeds some predetermined value that is less than that required to operate the overcurrent protective device of the supply circuit.

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

Health care facilities. Buildings or portions of buildings in which medical, dental, psychiatric, nursing, obstetrical, or surgical care are provided.

Note to the definition of ''health care facilities:'' Health care facilities include, but are not limited to, hospitals, nursing homes, limited care facilities, clinics, medical and dental offices, and ambulatory care centers, whether permanent or movable.

Heating equipment. For the purposes of § 1910.306(g), the term ''heating equipment'' includes any equipment used for heating purposes if heat is generated by induction or dielectric methods.

Hoistway. Any shaftway, hatchway, well hole, or other vertical opening or space that is designed for the operation of an elevator or dumbwaiter.

Identified (as applied to equipment). Approved as suitable for the specific purpose, function, use, environment, or application, where described in a particular requirement.

Note to the definition of ''identified:'' Some examples of ways to determine suitability of equipment for a specific purpose, environment, or application include investigations by a nationally recognized testing laboratory (through listing and labeling), inspection agency, or other organization recognized under the definition of ''acceptable.''

Induction heating. The heating of a nominally conductive material due to its own I^2R losses when the material is placed in a varying electromagnetic field.

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

Insulated conductor. See Conductor, Insulated.

Interrupter switch. (Over 600 volts, nominal.) A switch capable of making, carrying, and interrupting specified currents.

Irrigation Machine. An electrically driven or controlled machine, with one or more motors, not hand portable, and used primarily to transport and distribute water for agricultural purposes.

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

Isolated power system. A system comprising an isolating transformer or its equivalent, a line isolation monitor, and its ungrounded circuit conductors.

Labeled. Equipment is ''labeled'' if there is attached to it a label, symbol, or other identifying mark of a nationally recognized testing laboratory:

(1) That makes periodic inspections of the production of such equipment, and

(2) Whose labeling indicates compliance with nationally recognized standards or tests to determine safe use in a specified manner.

Lighting outlet. An outlet intended for the direct connection of a lampholder, a lighting fixture, or a pendant cord terminating in a lampholder.

Line-clearance tree trimming. The pruning, trimming, repairing, maintaining, removing, or clearing of trees or cutting of brush that is within 305 cm (10 ft) of electric supply lines and equipment.

Listed. Equipment is ''listed'' if it is of a kind mentioned in a list that:

(1) Is published by a nationally recognized laboratory that makes periodic inspection of the production of such equipment, and

(2) States that such equipment meets nationally recognized standards or has been tested and found safe for use in a specified manner.

Live parts. Energized conductive components.

Location—(1) *Damp location.* Partially protected locations under canopies, marquees, roofed open porches, and like locations, and interior

locations subject to moderate degrees of moisture, such as some basements, some barns, and some cold-storage warehouses.

(2) *Dry location.* A location not normally subject to dampness or wetness. A location classified as dry may be temporarily subject to dampness or wetness, as in the case of a building under construction.

(3) *Wet location.* Installations underground or in concrete slabs or masonry in direct contact with the earth, and locations subject to saturation with water or other liquids, such as vehicle-washing areas, and locations unprotected and exposed to weather.

Medium voltage cable (Type MV). A single or multiconductor solid dielectric insulated cable rated 2001 volts or higher.

Metal-clad cable (Type MC). A factory assembly of one or more insulated circuit conductors with or without optical fiber members enclosed in an armor of interlocking metal tape, or a smooth or corrugated metallic sheath.

Mineral-insulated metal-sheathed cable (Type MI). Type MI, mineral-insulated metal-sheathed, cable is a factory assembly of one or more conductors insulated with a highly compressed refractory mineral insulation and enclosed in a liquidtight and gastight continuous copper or alloy steel sheath.

Mobile X-ray. X-ray equipment mounted on a permanent base with wheels or casters or both for moving while completely assembled.

Motor control center. An assembly of one or more enclosed sections having a common power bus and principally containing motor control units.

Nonmetallic-sheathed cable (Types NM, NMC, and NMS). A factory assembly of two or more insulated conductors having an outer sheath of moisture resistant, flame-retardant, nonmetallic material.

Oil (filled) cutout. (Over 600 volts, nominal.) A cutout in which all or part of the fuse support and its fuse link or disconnecting blade are mounted in oil with complete immersion of the contacts and the fusible portion of the conducting element (fuse link), so that arc interruption by severing of the fuse link or by opening of the contacts will occur under oil.

Open wiring on insulators. Open wiring on insulators is an exposed wiring method using cleats, knobs, tubes, and flexible tubing for the protection and support of single insulated conductors run in or on buildings, and not concealed by the building structure.

Outlet. A point on the wiring system at which current is taken to supply utilization equipment.

Outline lighting. An arrangement of incandescent lamps or electric discharge lighting to outline or call attention to certain features, such as the shape of a building or the decoration of a window.

Overcurrent. Any current in excess of the rated current of equipment or the ampacity of a conductor. It may result from overload, short circuit, or ground fault.

Overhaul means to perform a major replacement, modification, repair, or rehabilitation similar to that involved when a new building or facility is built, a new wing is added, or an entire floor is renovated.

Overload. Operation of equipment in excess of normal, full-load rating, or of a conductor in excess of rated ampacity that, when it persists for a sufficient length of time, would cause damage or dangerous overheating. A fault, such as a short circuit or ground fault, is not an overload. (See Overcurrent.)

Panelboard. A single panel or group of panel units designed for assembly in the form of a single panel; including buses, automatic overcurrent devices, and with or without switches for the control of light, heat, or power circuits; designed to be placed in a cabinet or cutout box placed in or against a wall or partition and accessible only from the front. (See Switchboard.)

Permanently installed decorative fountains and reflection pools. Pools that are constructed in the ground, on the ground, or in a building in such a manner that the fountain or pool cannot be readily disassembled for storage, whether or not served by electrical circuits of any nature. These units are primarily constructed for their aesthetic value and are not intended for swimming or wading.

Permanently installed swimming, wading, and therapeutic pools. Pools that are constructed in the ground or partially in the ground, and all other capable of holding water in a depth greater than 1.07 m (42 in.). The definition also applies to all pools installed inside of a building, regardless of water depth, whether or not served by electric circuits of any nature.

Portable X-ray. X-ray equipment designed to be hand-carried.

Power and control tray cable (Type TC). A factory assembly of two or more insulated conductors, with or without associated bare or covered grounding conductors under a nonmetallic sheath, approved for installation in cable trays, in raceways, or where supported by a messenger wire.

Power fuse. (Over 600 volts, nominal.) See Fuse.

Power-limited tray cable (Type PLTC). A factory assembly of two or more insulated conductors under a nonmetallic jacket.

Power outlet. An enclosed assembly, which may include receptacles, circuit breakers, fuseholders, fused switches, buses, and watt-hour meter mounting means, that is intended to supply and control power to mobile homes, recreational vehicles, or boats or to serve as a means for distributing power needed to operate mobile or temporarily installed equipment.

Premises wiring. (Premises wiring system.) The interior and exterior wiring, including power, lighting, control, and signal circuit wiring together with all of their associated hardware, fittings, and wiring devices, both permanently and temporarily installed, that extends from the service point of utility conductors or source of power (such as a battery, a solar photovoltaic system, or a generator, transformer, or converter) to the outlets. Such wiring does not include wiring internal to appliances, fixtures, motors, controllers, motor control centers, and similar equipment.

Qualified person. One who has received training in and has demonstrated skills and knowledge in the construction and operation of electric equipment and installations and the hazards involved.

Note 1 to the definition of ''qualified person:'' Whether an employee is considered to be a ''qualified person'' will depend upon various circumstances in the workplace. For example, it is possible and, in fact, likely for an individual to be considered ''qualified'' with regard to certain equipment in the workplace, but ''unqualified'' as to other equipment. (See 1910.332(b)(3) for training requirements that specifically apply to qualified persons.)

Note 2 to the definition of ''qualified person:'' An employee who is undergoing on-the-job training and who, in the course of such training, has demonstrated an ability to perform duties safely at his or her level of training and who is under the direct supervision of a qualified person is considered to be a qualified person for the performance of those duties.

Raceway. An enclosed channel of metal or nonmetallic materials designed expressly for holding wires, cables, or busbars, with additional functions as permitted in this standard. Raceways include, but are not limited to, rigid metal conduit, rigid nonmetallic conduit, intermediate metal conduit, liquidtight flexible conduit, flexible metallic tubing, flexible metal conduit, electrical metallic tubing, electrical

nonmetallic tubing, underfloor raceways, cellular concrete floor raceways, cellular metal floor raceways, surface raceways, wireways, and busways.

Readily accessible. Capable of being reached quickly for operation, renewal, or inspections, so that those needing ready access do not have to climb over or remove obstacles or to resort to portable ladders, chairs, etc. (See Accessible.)

Receptacle. A receptacle is a contact device installed at the outlet for the connection of an attachment plug. A single receptacle is a single contact device with no other contact device on the same yoke. A multiple receptacle is two or more contact devices on the same yoke.

Receptacle outlet. An outlet where one or more receptacles are installed.

Remote-control circuit. Any electric circuit that controls any other circuit through a relay or an equivalent device.

Sealable equipment. Equipment enclosed in a case or cabinet that is provided with a means of sealing or locking so that live parts cannot be made accessible without opening the enclosure. The equipment may or may not be operable without opening the enclosure.

Separately derived system. A premises wiring system whose power is derived from a battery, a solar photovoltaic system, or from a generator, transformer, or converter windings, and that has no direct electrical connection, including a solidly connected grounded circuit conductor, to supply conductors originating in another system.

Service. The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

Service cable. Service conductors made up in the form of a cable.

Service conductors. The conductors from the service point to the service disconnecting means.

Service drop. The overhead service conductors from the last pole or other aerial support to and including the splices, if any, connecting to the service-entrance conductors at the building or other structure.

Service-entrance cable. A single conductor or multiconductor assembly provided with or without an overall covering, primarily used for services, and is of the following types:

(1) *Type SE.* Type SE, having a flame-retardant, moisture resistant covering; and

(2) *Type USE.* Type USE, identified for underground use, having a moisture-resistant covering, but not required to have a flame-retardant covering. Cabled, single-conductor, Type USE constructions recognized for underground use may have a bare copper conductor cabled with the assembly. Type USE single, parallel, or cable conductor assemblies recognized for underground use may have a bare copper concentric conductor applied. These constructions do not require an outer overall covering.

Service-entrance conductors, overhead system. The service conductors between the terminals of the service equipment and a point usually outside the building, clear of building walls, where joined by tap or splice to the service drop.

Service entrance conductors, underground system. The service conductors between the terminals of the service equipment and the point of connection to the service lateral.

Service equipment. The necessary equipment, usually consisting of one or more circuit breakers or switches and fuses, and their accessories, connected to the load end of service conductors to a building or other structure, or an otherwise designated area, and intended to constitute the main control and cutoff of the supply.

Service point. The point of connection between the facilities of the serving utility and the premises wiring.

Shielded nonmetallic-sheathed cable (Type SNM). A factory assembly of two or more insulated conductors in an extruded core of moisture-resistant, flame-resistant nonmetallic material, covered with an overlapping spiral metal tape and wire shield and jacketed with an extruded moisture-, flame-, oil-, corrosion-, fungus-, and sunlight-resistant nonmetallic material.

Show window. Any window used or designed to be used for the display of goods or advertising material, whether it is fully or partly enclosed or entirely open at the rear and whether or not it has a platform raised higher than the street floor level.

Signaling circuit. Any electric circuit that energizes signaling equipment.

Storable swimming or wading pool. A pool that is constructed on or above the ground and is capable of holding water to a maximum depth of 1.07 m (42 in.), or a pool with nonmetallic, molded polymeric walls or inflatable fabric walls regardless of dimension.

Switchboard. A large single panel, frame, or assembly of panels on which are mounted, on the face or back, or both, switches, overcurrent and other protective devices, buses, and (usually) instruments. Switchboards are generally accessible from the rear as well as from the front and are not intended to be installed in cabinets. (See Panelboard.)

Switch—(1) *General-use switch.* A switch intended for use in general distribution and branch circuits. It is rated in amperes, and it is capable of interrupting its rated current at its rated voltage.

(2) *General-use snap switch.* A form of general-use switch constructed so that it can be installed in device boxes or on box covers, or otherwise used in conjunction with wiring systems recognized by this subpart.

(3) *Isolating switch.* A switch intended for isolating an electric circuit from the source of power. It has no interrupting rating, and it is intended to be operated only after the circuit has been opened by some other means.

(4) *Motor-circuit switch.* A switch, rated in horsepower, capable of interrupting the maximum operating overload current of a motor of the same horsepower rating as the switch at the rated voltage.

Switching devices. (Over 600 volts, nominal.) Devices designed to close and open one or more electric circuits. Included in this category are circuit breakers, cutouts, disconnecting (or isolating) switches, disconnecting means, interrupter switches, and oil (filled) cutouts.

Transportable X-ray. X-ray equipment installed in a vehicle or that may readily be disassembled for transport in a vehicle.

Utilization equipment. Equipment that utilizes electric energy for electronic, electromechanical, chemical, heating, lighting, or similar purposes.

Ventilated. Provided with a means to permit circulation of air sufficient to remove an excess of heat, fumes, or vapors.

Volatile flammable liquid. A flammable liquid having a flash point below 38 °C (100 °F), or a flammable liquid whose temperature is above its flash point, or a Class II combustible liquid having a vapor pressure not exceeding 276 kPa (40 psia) at 38 °C (100 °F) and whose temperature is above its flash point.

Voltage (of a circuit). The greatest root-mean-square (rms) (effective) difference of potential between any two conductors of the circuit concerned.

Voltage, nominal. A nominal value assigned to a circuit or system for the purpose of conveniently designating its voltage class (as 120/240 volts, 480Y/277 volts, 600 volts). The actual voltage at which a circuit operates can vary from the nominal within a range that permits satisfactory operation of equipment.

Voltage to ground. For grounded circuits, the voltage between the given conductor and that point or conductor of the circuit that is grounded; for ungrounded circuits, the greatest voltage between the given conductor and any other conductor of the circuit.

Watertight. So constructed that moisture will not enter the enclosure.

Weatherproof. So constructed or protected that exposure to the weather will not interfere with successful operation. Rainproof, raintight, or watertight equipment can fulfill the requirements for weatherproof where varying weather conditions other than wetness, such as snow, ice, dust, or temperature extremes, are not a factor.

Wireways. Sheet-metal troughs with hinged or removable covers for housing and protecting electric wires and cable and in which conductors are laid in place after the wireway has been installed as a complete system.

■ 8. Appendix A to Subpart S is revised to read as follows:

Appendix A—References for Further Information

The references contained in this appendix provide nonmandatory information that can be helpful in understanding and complying with Subpart S of this Part. However, compliance with these standards is not a substitute for compliance with Subpart S of this Part.

ANSI/API RP 500–1998 (2002) *Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I Division 1 and Division 2.*

ANSI/API RP 505–1997 (2002) *Recommended Practice for Classification of Locations for Electrical Installations at Petroleum Facilities Classified as Class I, Zone 0, Zone 1 and Zone 2.*

ANSI/ASME A17.1–2004 *Safety Code for Elevators and Escalators.*

ANSI/ASME B30.2–2005 *Overhead and Gantry Cranes (Top Running Bridge, Single or Multiple Girder, Top Running Trolley Hoist).*

ANSI/ASME B30.3–2004 *Construction Tower Cranes.*

ANSI/ASME B30.4–2003 *Portal, Tower, and Pedestal Cranes.*

ANSI/ASME B30.5–2004 *Mobile And Locomotive Cranes.*

ANSI/ASME B30.6–2003 *Derricks.*

ANSI/ASME B30.7–2001 *Base Mounted Drum Hoists.*

ANSI/ASME B30.8–2004 *Floating Cranes And Floating Derricks.*

ANSI/ASME B30.11–2004 *Monorails And Underhung Cranes.*

ANSI/ASME B30.12–2001 *Handling Loads Suspended from Rotorcraft.*

ANSI/ASME B30.13–2003 *Storage/Retrieval (S/R) Machines and Associated Equipment.*

ANSI/ASME B30.16–2003 *Overhead Hoists (Underhung).*

ANSI/ASME B30.22–2005 *Articulating Boom Cranes.*

ANSI/ASSE Z244.1–2003 *Control of Hazardous Energy Lockout/Tagout and Alternative Methods.*

ANSI/ASSE Z490.1–2001 *Criteria for Accepted Practices in Safety, Health, and Environmental Training.*

ANSI/IEEE C2–2002 *National Electrical Safety Code.*

ANSI K61.1–1999 *Safety Requirements for the Storage and Handling of Anhydrous Ammonia.*

ANSI/UL 913–2003 *Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations.*

ASTM D3176–1989 (2002) *Standard Practice for Ultimate Analysis of Coal and Coke.*

ASTM D3180–1989 (2002) *Standard Practice for Calculating Coal and Coke Analyses from As-Determined to Different Bases.*

NFPA 20–2003 *Standard for the Installation of Stationary Pumps for Fire Protection.*

NFPA 30–2003 *Flammable and Combustible Liquids Code.*

NFPA 32–2004 *Standard for Drycleaning Plants.*

NFPA 33–2003 *Standard for Spray Application Using Flammable or Combustible Materials.*

NFPA 34–2003 *Standard for Dipping and Coating Processes Using Flammable or Combustible Liquids.*

NFPA 35–2005 *Standard for the Manufacture of Organic Coatings.*

NFPA 36–2004 *Standard for Solvent Extraction Plants.*

NFPA 40–2001 *Standard for the Storage and Handling of Cellulose Nitrate Film.*

NFPA 58–2004 *Liquefied Petroleum Gas Code.*

NFPA 59–2004 *Utility LP-Gas Plant Code.*

NFPA 70–2002 *National Electrical Code. (See also NFPA 70–2005.)*

NFPA 70E–2000 *Standard for Electrical Safety Requirements for Employee Workplaces. (See also NFPA 70E–2004.)*

NFPA 77–2000 *Recommended Practice on Static Electricity.*

NFPA 80–1999 *Standard for Fire Doors and Fire Windows.*

NFPA 88A–2002 *Standard for Parking Structures.*

NFPA 91–2004 *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids.*

NFPA 101–2006 *Life Safety Code.*

NFPA 496–2003 *Standard for Purged and Pressurized Enclosures for Electrical Equipment.*

NFPA 497–2004 *Recommended Practice for the Classification of Flammable Liquids, Gases, or Vapors and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas.*

NFPA 505–2006 *Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operation.*

NFPA 820–2003 *Standard for Fire Protection in Wastewater Treatment and Collection Facilities.*

NMAB 353–1–1979 *Matrix of Combustion-Relevant Properties and Classification of Gases, Vapors, and Selected Solids.*

NMAB 353–2–1979 *Test Equipment for Use in Determining Classifications of Combustible Dusts.*

NMAB 353–3–1980 *Classification of Combustible Dust in Accordance with the National Electrical Code.*

Appendices B and C [Removed]

■ 9. Appendices B and C to Subpart S are removed.

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