DEPARTMENT OF LABOR

Occupational Safety and Health Administration

29 CFR Part 1910

Electrical Standards

AGENCY: Occupational Safety and Health Administration, U.S. Department of Labor.

ACTION: Final standard

SUMMARY: In this final standard, the Occupational Safety and Health Administration (OSHA) establishes "Design Safety Standards for Electrical Systems." This standard revises Subpart S of 29 CFR Part 1910 and is intended to simplify and update the former standard. OSHA has determined that electrical hazards in the workplace pose a significant risk of injury or death to employees, and that these regulations which draw heavily on the experience of the National Electrical Code are reasonably necessary to provide protection from these hazards. The final rule places relevant requirements of the National Electrical Code (NEC) into the text of the regulations, making it unnecessary for employers to refer to the NEC to determine their obligations and unnecessary for OSHA to continue to incorporate the NEC by reference. Additionally, the final rule clarifies certain provisions which were misunderstood by certain interested parties.

EFFECTIVE DATE: This revision of 29 CFR Part 1910, Subpart S becomes effective on April 16, 1981.

FOR FURTHER INFORMATION CONTACT: For information on the standard contact: Mr. Jerry Leonard or Mr. David Wallis; Office of Electrical and Electronic Engineering Safety Standards; OSHA; Rm. N3510; 200 Constitution Avenue, NW., Washington, D.C. 20210. (202–523–7207).

For information on compliance contact: Mr. Peter Wasko; Federal Compliance and State Programs; Division of Safety Programming; OSHA; Rm. N3106; 200 Constitution Avenue, NW, Washington, D.C. 20210. (202–523–8124).

For additional copies of this regulation contact: OSHA Office of Publications; U.S. Department of Labor; Room S–1212; Washington, D.C. 20210. (202–523–8677).

SUPPLEMENTARY INFORMATION:

I. Background

(1) Safety Problems of Electric Shock

It is well known that the human body will conduct electricity, and that if direct body contact is made with an electrically energized part while a similar contact is made simultaneously with another conductive surface which 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 workers suffer pain, injuries and death from such electric shocks and throughout the past decade the National Center for Health Statistics has reported approximately 1000 accidental electrocutions annually in the United States with about a fourth being industry and farm related.

The effects that electric shock will have on an individual will depend upon the type of circuit, its voltage, resistance, amperage, pathway through the body and the duration of the contact. For example, electric shocks produced by alternating currents of powerline frequency (normally 60 Hertz) passing through the body from hand to foot for an average adult worker for one second can cause various effects on the body. Such effects range from a condition of being barely perceptible at 1 milliampere to involuntary muscular control from 9 to 25 milliamperes. The passage of still higher currents can produce ventricular fibrillation of the heart (cessation of rhythmic pumping action) from 75 milliamperes to 4 amperes and finally immediate cardiac arrest at over 4 amperes. Nearly instantaneous fatalities from electric shock can result from either direct paralysis of the respiratory system (at 20 milliamperes or more), failure of the heart to pump due to ventricular fibrillation (at 75 milliamperes or more), or immediate and complete heart stoppage (at 4 amperes or more). Even if the shocking current does not pass through vital organs or nerve centers, severe injuries such as deep internal burns can still occur. In some cases, injuries caused by electric shock can be a contributory cause of delayed fatalities.

Burns suffered in electrical accidents are of great concern. 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 (muscles, bones, etc.) or both. Tissue damage is caused by the heat generated from the current flow; if the energy delivered by the electrical shock is high, the body cannot dissipate the heat and the tissue is burned. Typically, such electrical burns are slow to heal. Arc burns, on the other hand are the result of high temperatures in close proximity to the body produced by electric arcs or by explosions. These burns are similar to burns and blisters produced by any high temperature source. Finally, thermal contact burns are those normally experienced from the skin contacting hot surfaces of overheated electrical conductors, conduits, or other energized equipment. All types of burns may be produced simultaneously.

Electrical shock currents, 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 electrical shock can cause bruises, bone fractures and even death resulting from collisions or falls.

(2) Hazards Associated With Electricity

Most electrical systems use the earth to establish an electrical voltage reference system with respect to ground. This is done by connecting a portion of the circuit to ground. Since these systems use conductors which have voltages to ground, a shock hazard exists for persons who are in electrical contact with the earth and are exposed to the conductors. If a person comes in contact with an ungrounded conductor while he is in contact with the ground, he becomes part of the circuit and current passes through his body.

In addition to the shock hazard, electricity poses other hazards to employees. For example, when a short circuit occurs or current flow is interrupted, hazards are created from the resultant arcs. If high current is involved, these arcs can cause injury or 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 which contain explosive gases or vapors or combustible dusts, even low-energy arcs can cause violent explosions.

(3) Nature of Electrical Accidents

Electrical accidents, when initially studied, often appear to be caused by circumstances which 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. These consist of work involving unsafe equipment and installations, workplaces made unsafe

by the environment, and unsafe work performance.

(a) *Basic Contributory Factors.* Some unsafe electrical equipment and installations can be identified, for example, by the presence of faulty insulation, improper grounding, loose connections, defective parts, ground faults in equipment or unguarded live parts. The environment can also be a contributory factor to electrical accidents in a number of ways. Some unsafe environments affecting electrical safety would be, for example, atmospheres containing flammable vapors, liquids or gases, areas containing corrosive atmospheres, and wet and damp locations. Finally, some typical unsafe acts can be recognized as, for example, the failure to deenergize electrical equipment when it is being repaired or inspected, the intentional use of obviously defective and unsafe tools, or the use of tools or equipment too close to energized parts. For purposes of convenience, the first and second accident causing situations are sometimes combined and simply referred to as unsafe conditions. Thus, electrical accidents can be generally considered as being caused by unsafe conditions, unsafe acts, or, what is usually the case, combinations of the two. It should also be noted that inadequate maintenance can cause equipment or installations, which were originally considered safe, to deteriorate, resulting in an unsafe condition.

(b) *Typical Accidents from Unsafe Conditions.* Of the two primary causative factors influencing electrical accidents (i.e., unsafe conditions and unsafe acts) the ones involving unsafe conditions are more directly addressed by the provisions of the National Electrical Code. Since OSHA's revised electrical safety standards are initially directed towards minimizing unsafe conditions, a few typical examples of related accidents are given to illustrate these situations.

(i) California—1972. A nurseryman was electrocuted when he touched a conduit riser in a greenhouse. The greenhouse was wired with overhead open wiring on insulators. A short section of conduit was installed to enclose conductors feeding down to a time clock. A fulty splice in the clock energized the clock frame and conduit.

(ii) Florida—1973. A lead foreman and set-up man for a plastics corporation was installing a new injection molding machine. The employee was electrocuted when he touched a temperature control unit used in conjunction with the molding machine. The temperature control unit had been improperly wired.

(iii) Hawaii—1971. An installer of refrigerators for the retail-wholesale trade was electrocuted using an electric drill. While working on top of a prefabricated walk-in unit, the worker was in continuous ground contact when an electrical fault developed in the drill plug and the accident occurred.

(iv) California—1971. A worker engaged in electroplating was electrocuted when he touched an ungrounded 9 volt D.C. bus on an electroplating tank while in contact with the grounded tank. It was found that a 120-volt terminal on an A.C. timer coil was installed within ⅛ inch of the D.C. bus. A fault path had developed and a leakage current of 70 milliamperes at 120 volts was measured between the electroplating bus and the grounded tank.

(v) Florida—1974. A slag house operator for a slag plant was on a catwalk repairing and replacing guards on belt drives and pulleys. He had gained access to the catwalk by using a wooden ladder, but he descended from the catwalk by means of a power pole erected at the end of the platform. A 440-volt line with deteriorated insulation was anchored to the pole, and metal spikes for climbing and descending had been driven into the pole. As the victim stepped on the first cleat, he grabbed his chest, lost his grip and fell ten feet to the concrete floor. Electric shock was found to be the cause of death.

(vi) Idaho—1974. A lubricator working in the molding department of a plastics manufacturing plant was electrocuted. The accident resulted when the worker contacted a nozzle adaptor which was energized on the molding machine.

(vii) California—1966. An electrician received flash burns on his face when he closed a large 480-volt switch after replacing a blown fuse. The ceramic insulating block holding one end of the fuse was defective and apparently had originally caused the fuse to blow.

(viii) California—1972. A worker was electrocuted when he grasped the metal nozzle of a steam cleaning hose which was metal reinforced. The 120-volt switch in the motor terminal enclosure of the steam cleaning unit had vibrated loose and a terminal was contacting the metal enclosure. The unit was supplied by a three conductor cord; however, the ground prong on the attachment plug had been broken off. Another worker received a severe shock when he attempted to help the first worker.

(ix) Massachusetts—1970. A repairman working in an automobile body shop was electrocuted when the portable grinder which he was using developed a short circuit.

(x) Florida—1973. A carpenter's helper for a boat manufacturing firm was electrocuted when he plugged the router cord into an extension cord outlet box. Examination of the extension cord outlet box showed the ungrounded conductor had separated from its terminal and was touching the metal box.

While these electrical accident descriptions are typical, it must be emphasized that they only represent accidents within the category of unsafe conditions.

(c) Accident References. Although descriptive accident data was reviewed from a variety of sources, the typical representative data presented herein was taken from the following:

(i) Electrical Work Injuries in California, Department of Industrial Relations, Division of Industrial Safety State of California, 455 Golden Gate Avenue, San Francisco, CA 94101.

(ii) "Live and Learn" Publication, Department of Labor and Employment Security, Industrial Safety, State of Florida 1321 Executive Center Drive, East Tallahassee, Florida 32301.

(iii) Publication of Occupational-Related Electrocutions, Department of Labor and Industrial Relations, State of Hawaii, 825 Mililani Street, Honolulu, Hawaii 96813.

(iv) Industrial Accidents, Industrial Commission, State of Idaho, 317 Main Street, Boise, Idaho 83707.

(v) Department of Labor and Industries, Division of Industrial Safety, Commonwealth of Massachusetts, Leverett Saltonstall Bldg., Government Center, 100 Cambridge Street, Boston, MA 02202.

(4) Protective Measures and Present Regulations

There are various general ways of protecting employees from the hazards of electric shock, including insulation and guarding of live parts. Insulation provides an electrical barrier to the flow of current. To be effective, the insulation must be appropriate for the voltage, and the insulating material should be 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 reach from the working surface. (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. If a live part accidentally comes in contact with a grounded enclosure, any current flow is directed back to earth and the circuit protective devices (e.g., fuses and circuit breakers) can interrupt the circuit.

When employees are working with electrical equipment, they must use safe work practices. Such safety-related employee work practices include keeping a prescribed distance from exposed energized lines, avoiding the use of electrical equipment while wet, and locking-out and tagging equipment which is deenergized for maintenance.

Another important safety practice involves the use of electrical protective devices, such as rubber gloves and rubber mats for purposes of insulation against live parts, or hot sticks for purposes of both insulation and actuation of energized parts from a distance. However, to assure the protection of the employee, this equipment must be properly manufactured and maintained. With this equipment, regular maintenance becomes an important consideration in order to keep the equipment from deteriorating into an unsafe condition.

The regulations formerly contained in Subpart S of Part 1910 adopted the 1971 National Electrical Code by reference and set forth definitions with respect to some of the terms used by the NEC. The National Electrical Code is the most widely used code to safeguard people and property from the potential hazards associated with electricity. This code had its beginning prior to the turn of the century when the use of electricity was just starting. At this time, the code serves as the cornerstone of electrical safety in the United States. As such, it provides the basis for electrical safety regulations in over 2000 municipalities throughout all 50 States. Thirty-seven States and the District of Columbia have adopted it as their electrical safety law, and it is enforced by over 12,000 governmental electrical inspectors. This national system provides important assistance to OSHA in its mission to afford electrical safety in the workplace.

(5) Reasons for Proposed Revision

As noted earlier, electricity has long been recognized as a serious workplace hazard, exposing employees to such dangers as electric shock, electrocution, fires, and explosions. Indeed, the long history of the National Electrical Code attests to this fact. Since 1896, the NEC has represented the continuing efforts of experts in electrical safety to deal with these recognized hazards and to provide for safety 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 these regulations which draw heavily on the experience of the NEC, are reasonably necessary to provide protection from these hazards.

OSHA recognizes the important role that the NEC has played over the years in defining basic requirements for safety in electrical installations. The revision of Subpart S being promulgated by this document will maintain the protection presently afforded to employees by the 1971 NEC, as incorporated by reference in the present standards. While carrying forward those provisions which are considered necessary for employee safety, OSHA is providing greater flexibility for compliance with these provisions to the extent that employee safety warrants. OSHA has determined, therefore, that this revision of Subpart S contains requirements derived from the NEC which are reasonably necessary to protect employees from electrical hazards in the workplace.

Since the National Electrical Code (NEC) NFPA 70–1971 was adopted as a national consensus standard under Section 6(a) of the Act, three revisions of the NEC have been issued, the most recent being the 1981 edition. Because of the continual process by the National Fire Protection Association (NFPA) of updating the Code every three years, any specific edition which OSHA might adopt would likely be outdated within a few years. In addition, since the rulemaking process can become somewhat lengthy, a complete revision of the OSHA electrical safety standards every three years to keep pace with the NEC changes is not practical. To remedy this problem, OSHA's electrical safety standards should accommodate changes in technology without the need for constant revision and, where possible, be written in performance terms in order to allow alternative installation methods if they provide comparable safety to the employee.

Another difficulty with the current incorporation of the entire NEC by reference is that the NEC contains many details which are not directly related to employee safety. In addition, a further objective of OSHA in revising the standard is to obtain an improved standard which will provide employee safety and will be easier to use and understand, but will still be comprehensive enough to cover all significant electrical hazards.

Finally, since the NEC is an electrical installation design document, it does not generally contain explicit requirements for electricial safety-related work practices, electrical equipment maintenance or safety requirements for special equipment. OSHA, therefore, will also consider the development of regulations in these areas in subsequent rulemaking proceedings.

(6) General Approach

In view of the existing constraints and limitations imposed by the continued use of the 1971 version of the NEC, discussed previously, OSHA concluded that a revised standard tailored to fulfill OSHA's responsibilities and which would extract suitable portions from the NEC and other safety standards applicable to electrical safety was needed.

At the same time, and after discussions with OSHA staff, the NFPA decided that the NEC Correlating Committee, which periodically evaluates the NEC, should examine the feasibility of developing a document to be used as a basis for providing electrical safety in the workplace. In 1976, NFPA established the "70E Committee" to prepare a consensus standard for possible use by OSHA in developing a proposal for subsequent rulemaking. The 70E Committee visualized a standard consisting of four major parts:

Part I—Installation Safety Requirements,

Part II— Safety Related Work Practices,

Part III—Safety-Related Maintenance Requirements,

Part IV—Safety Requirements for Special Equipment.

The name given to this new document became NFPA 70E, "Electrical Safety Requirements for Employee Workplaces."

(7) Criteria for Part I of NFPA 70E

The NFPA 70E Committee derived Part I from the 1978 NEC; however, unlike the NEC, this Part was not intended to be applied as a design, installation, modification, or construction standard for an electrical installation or system. Rather, its content was excerpted from the NEC in order to apply only to electrical utilization systems which were part of the workplace. Although Part I of NFPA 70E is compatible with corresponding provisions of the NEC, it is not intended to be used, nor can it be used, in lieu of the NEC for the design and initial installation of utilization systems and equipment.

Although all of the requirements of the NEC may be related to electrical hazards, for practical purposes the Committee included in Part I of NFPA 70E provisions which are most directly associated with employee safety. In

determining which provisions should be included in Part I, the following guidelines were used by the 70E Committee.

(a) The provisions should give protection to the employee from electrical hazards.

(b) The provisions should be excerpted from the NEC in a manner that will maintain their intent as they apply to employee safety.

(c) The provisions should be selected and written in a manner that will reduce the need for frequent revision and avoid technological obsolescence.

(d) Compliance with the provisions should be determinable by means of an inspection during the normal state of employee occupancy without requiring shutdown of the electrical installation or damage to the building or finish.

(e) The provisions should not be encumbered with unnecessary details.

(f) The provisions should be written so as to enhance their understanding by the employer and employee.

(g) The provisions must not add any requirements not found in the NEC, nor may the intent of the NEC be changed even if the wording is changed.

(8) Source of 70E

The 1978 edition of the NEC was used as a source document for NFPA 70E, instead of the 1971 edition. Part I of 70E reflects a considerable improvement over the present OSHA standards incorporated in Subpart S. Generally, this improvement may be considered as being one achieved more from the elimination of requirements inappropriate to OSHA's needs rather than from the addition of new requirements. Typical examples of this method of simplification in the preparation of Part I of 70E relate to NEC chapters 3, 4, 6, 7, and 9, as discussed below. Although 70E does contain some additional requirements not contained in the 1971 NEC (as in chapters 6 and 7 of the 1978 NEC), such new provisions are relatively few in number.

Major deletions and additions, typical of those made in the preparation of 70E, are given in the following paragraphs:

(a) *Principal Deletions.* Chapters 3 and 4 of the 1971 and 1978 NEC deal with wiring methods and materials (Chapter 3) and equipment for general use (Chapter 4). Tables containing various specialized technical information have been deleted in 70E.

Typical topics of these chapters included insulation characteristics, allowable ampacities, electrical box sizes, flexible cord and motor full load currents. This type of information was deleted because it deals with items not directly related to the electrical hazard. For example, the composition of insulation on a conductor was deleted; however, the actual requirement that the conductor be insulated and that the insulation be approved for its intended purpose was retained. These changes result in a standard which is more performance oriented.

Chapter 6 of the 1971 and 1978 NEC describes special equipment requirements. Requirements from this chapter dealing with electrically operated organs and the installation of equipment and wiring used for sound-recording and reproduction have been deleted in 70E because electrical safety for employees is not directly affected by these items. Any hazard to the employee related to this type of equipment would most likely arise in the supply system which will still be covered.

Chapter 7 of the 1971 and 1978 NEC deals with special conditions. All requirements from this chapter involving stand-by power generation systems permanently installed, other than emergency systems, have been deleted. In these situations, primary electrical hazards to the worker are minimal since the effects of power outage are generally limited to product or process damage.

Chapter 9 of the 1971 and 1978 NEC provides a collection of tables containing technical data, together with a number of sample computations. This entire chapter is not included in 70E because it is solely and instructive guide for the design of certain electrical systems.

(b) *Principal Additions.* Chapter 6 of the 1971 NEC which deals with special equipment, has been supplemented by additional requirements found in the 1978 edition of the NEC. These additions are included in 70E. Specifically, new provisions for workplaces containing electrically driven or controlled irrigation machines and workplaces using electrolytic cells have been added. In the first type of workplace, the related electrical hazard is associated with the presence of an electrically driven or controlled machine, with one or more motors, used primarily to transport and distribute water for agricultural purposes. In the second type of workplace, equipment is installed consisting of electrolytic cells used for the purpose of refining or producing various materials. Such an installation contains electrical hazards because the employee's work is normally performed on or in the vicinity of exposed energized surfaces of the electrolytic cell lines and their attachments. As a consequence, special electrical safety requirements are needed and hence such provisions are included in 70E.

Chapter 7 of the 1971 NEC covers special conditions. An addition contained in the 1978 NEC involves fire protective signaling systems. Inasmuch as the installation of wiring and equipment of fire protective signaling systems, operating at 600 volts or less, has a definite effect on workplace safety, the new provisions have been included in 70E.

II. History of Regulation

The need for an uncomplicated and readily understandable standard, sufficiently general to minimize the need for changes, appeared to be satisfied by Part I of the NFPA 70E recommendations. OSHA carefully reviewed the work product of the 70E Committee and determined that its use as a source document for OSHA's design safety standard for electical utilization systems and equipment was appropriate and offered certain advantages in achieving a more simplified standard. OSHA prepared a notice of proposed rulemaking which contained proposed amendments of the electrical safety standards in Subpart S of 29 CFR Part 1910. The proposal was published in the **Federal Register** (44 FR 55274) on September 25, 1979. On November 20, 1979, OSHA published a notice correcting the proposal and extending the comment period (44 FR 66621).

The proposal represented an attempt to develop a comprehensive standard which would protect employees from recognized electrical hazards in the workplace. This was accomplished by examining the existing standards, the 1975 and 1978 edition of the NEC. The proposal streamlined the existing standard, which incorporated by reference the whole 1971 NEC, by deleting portions of the NEC which were not directly related to employee safety. OSHA's proposed revisions provided more flexibility, allowing employers alternative methods of compliance by phrasing the standard in terms of performance instead of specification.

The notice of proposed rulemaking invited interested persons to submit written comments on the proposed standard, to participate in a public meeting (which was held on November 8, 1979), and to file objections and requests for a public hearing. The original date for the close of the comment period was set for November 30, 1979, but was subsequently extended, at the request of commenters, to December 31, 1979 (44 FR 66621). Over 190 written comments were received, including several requests for a hearing which identified eight major issues:

1. Whether the proposal should be more performance oriented or, on the other hand, should provide greater specification.

2. Whether the scope of the standard is clear with respect to its coverage of public utilities.

3. Whether the proposal would change the existing "grandfathering" and "retroactive" provisions.

4. Whether the marking and approval requirements in proposed §§ 1910.303(a), 1910.303(e), and 1910.307(b)(4) deviate from the existing regulations and whether they relate to employee safety.

5. Whether the impedance and ampacity requirements of National Electrical Code (NEC) Section 250–51 should be included in the standard.

6. Whether the prohibition of the use of structural metal frames of buildings as the equipment grounding conductor (1978 NEC 250–58(a)) should be included in the standard.

7. Whether the definitions for Class II locations and their associated explanatory notes should be changed.

8. Whether installations of electrolytic cells should be covered by the guarding provisons of proposed § 1910.303.

In response to these hearing requests, OSHA published a notice of public hearing, listing these issues (45 FR 10375). The informal rulemaking hearing was convened by Judge Harmon Maxson on May 6, 1980, pursuant to section 6(b)(3) of the Act (29 U.S.C. 655(b)(3)) and 29 CFR Part 1911. The hearing lasted through May 8, 1980, and included testimony from over 50 witnesses. Judge Maxson established a post-hearing period for the submission of additional comments and briefs extending through July 8, 1980.

The entire record, including 73 exhibits, 5 addenda, and 490 transcript pages, was certified by Judge Maxson on August 27, 1980, in accordance with 29 CFR 1911.17. Copies of materials in the record, as well as an index of the record, may be obtained from the OSHA Docket Office, Room S6212, Frances Perkins Building, 200 Constitution Avenue, NW, Washington, D.C. 20210

This final standard is based on a full consideration of the entire record of this proceeding including materials discussed or relied on in the proposal, the record of the informal hearing, and all written comments and exhibits received.

III. Issues

The evidence submitted into the record is summarized and evaluated in the following discussions of each issue. The numbers in brackets refer to specific references in the May 6, 7, and 8, 1980, hearing exhibits (Ex.) and hearing transcript page numbers (Tr.).

1. *Whether the proposal should be more performance oriented or, on the other hand, should provide greater specification.*

Most of the language of the proposed standards was taken directly from the National Electrical Code. This was done to maintain continuity with the existing regulations, which incorporated the entire 1971 NEC by reference. Where the NEC language was rewritten emphasis was given to performance oriented terms. As stated by one witness, the criteria used by the NFPA 70E Committee in developing the base document was: "Whenever practicable, the standard promulgated shall be expressed in terms of objective criteria and of the performace desired" (Tr. 394). However, some commenters felt that the proposal was still too specific and suggested that the entire standard be more general. One commenter stated:

> Most accidents do not result from lack of or conformance to specification, but are performance failures, such as human and/or environmental failures. Another deficiency of specification standards is that the inflexibility of specification standards leads to specification-type citations which frequently fail to correct accident causes. * * * So long as a standard is specification oriented, it is sterile and freezes in place the state of technology and scientific applications to the industry (Ex. 44).

In a later submission, the same commenter stated, "The standards should allow the employer the use of reasoned judgment in the application of innovative methods, new technology and cost-saving practices so long as worker safety is not jeopardized" (Ex. 61). This commenter had earlier submitted an annotated copy of the proposal with suggested changes for all paragraphs which they felt were too specific (Ex. 2). Another comment contained a suggested revision of the entire standard which would reduce it to two pages of very general terms and stated, "Performance orientation allows for rapid technological improvements, alternative methods of accomplishing employee safety and a reduction of nuisance citations" (Ex. 12). In addition, a witness stated, "When specifications are detailed to this degree, they place a burden on OHSA compliance officers to become unnecessarily proficient in the technical language and application of the National Electrical Code and the proposed regulations" (Tr. 417–418).

In contrast to testimony supporting more general standards, one witness stated, "The most obvious and serious defect is the emphasis on writing the standard in general terms * * * The [Review] Commission and the circuit courts have ruled, in some instances, that standards written in general terms are vague and unenforceable" (Tr. 227).

A certain balance is required in order to make the standard both flexible and at the same time enforceable. OSHA has tried to make the standard as performance oriented as possible. However, it is impossible to express the standard in only performance terms without providing some specifications for employers and compliance officers. The final rule as adopted, therefore, is essentially a performance standard, with specifications included where necessary.

2. *Whether the scope of the standard is clear with respect to its coverage of public utilities.*

The scope of OHSA's former standard was stated in § 1910.308(c). The so-called "utility exemption" was contained in paragraph (c)(2)(v) and was identical to 1971 NEC Section 90–2(b)(5). In the proposal, OHSA continued the "exemption" in § 1910.302(e)(2)(v), which read the same as the earlier version:

> (2) *Not covered.* * * *
>
> (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 the 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 priviate property.

OHSA's interpretation of this regulation, as stated at the public hearing, has been that "this provision excludes the *installations* of electric utilities used for such purposes as the generation, control, transformation, transmission and distribution of electric energy. Other codes and standards such as ANSI C–2, National Electrical Safety Code, address the installation design requirements for these facilities. Therefore, the NEC does not address these areas of electric design" (Tr. 25, emphasis added).

As stated by witnesses at the hearing, the scope provision of the standard does not grant exemptions (Tr. 68, 259, 426). Instead, the "utility exemption", as it is referred to, is simply a statement of installations which were never intended to be within the scope of the NEC, or of this standard. In other words the standard, like the NEC, does not contain provisions which are appropriate for dealing with utility installations either for the generation, control, transformation, transmission, and

distribution of electric energy, or for the purpose of communication or metering.

However, other utility installations not of the type noted above are covered. A proposal was submitted to the 1981 code writing panels to clarify the intent of the scope paragraphs. As noted by some witnesses (Tr. 261, 427), this proposal was accepted and a revised fine print note was added to the proposed 1981 NEC, reading as follows:

It is the intent of this section that this Code covers all premises' wiring or wiring other than utility owned metering equipment, on the load side of the service point of buildings, structures, or any other premises not owned or leased by the utility. Also, it is the intent that this Code cover installations in buildings used by the utility for purposes other than listed in (b–5) above, such as office buildings, warehouses, garages, machine shops, recreational buildings which are not an integral part of a generating plant, substation, or control center.

The language of § 1910.302(a)(2)(v) provides that portions of a utility installation which are not integral parts of a generating plant, substation, or control center are covered by the standard.

The position that all aspects of public utlities operation should be covered by the proposed regulations was raised by two commenters. The first commenter expressed the concern that a large number of workers would not be protected by an electrical standard if the public utility industry were exempted from this standard. He cited a Bureau of Labor Statistics News Release which stated that six of every 10 fatalities from contact with electric current occurred to workers in the construction, transportation and public utilites industries (Ex. 25). However, most of those fatalities were in the construction industry; and, since the causes of those fatalities occurring in the transportation and public utilities industries were not broken down, it is not clear how many may have been caused by conditions covered in the regulations of this Subpart. Expressing the same concern, the other commenter stated, "To excluse the utility industry from Subpart S (electrical) of the Occupational Safety and Health Act is to deny fair and equal safety coverage to the largest number of workers exposed to these hazards on a daily basis." In support of his objection, this witness described several electrical accidents of which he had personal knowledge (Ex. 26). However, it must be noted that the causes of these accidents were related to construction and maintenance of power transmission and distribution lines and equipment; the electrical standards of Part 1910 do not apply to construction activities. (Regulations for the construction of power transmission and distribution lines are contained in OHSA's construction standards (29 CFR Part 1926). Regulations on the maintenance and design of these lines and equipment will be considered in future rulemakings.)

The question of whether other industries should have the same exemption as public utilities in areas where they are performing the same operations was raised by steel industry representatives (Ex. 61). As they noted, the National Electrical Safety Code (ANSI C-2) contains regulations covering the generation, control, transformation, transmission and distribution of electric energy. ANSI C-2 does specifically say in its scope that it is applicable to the systems and equipment operated by utilities, or similar systems and equipment of an industrial establishment or complex under the control of qualified persons. While questioning a witness representing the Edison Electric Institute, a steel industry representative noted that while the NEC and OSHA's Subpart S cover industrial substations, the ANSI C-2 Code says that it, too, covers industrial equipment, thus producing a conflict or overlap (Tr. 350).

The NEC and OSHA's Subpart S do contain provisions which are appropriate for most industrial substations. Such facilities are included in the scope of this standard, because they vary widely in the power and voltage involved and in the type of equipment that is used. While some industrial facilities may only include utility type equipment and operate similarly to a utility, this is not the general case. As a rule utilities operate at much higher voltages and with specially trained employees. In the situations where the industrial operation may be the same as that of an electric utility, there would not be an overlap since ANSI C-2 contains the provisions which would apply and neither the NEC nor OSHA's Subpart S contain provisions which would be applicable. However, since provisions are included in these standards which are appropriate for most industrial substations, these installations have been included in the scope of the final rule.

3. *Whether the proposal would change the existing "grandfathering" and "retroactive" provisions.*

a. *Terminology.*

The term "retroactive" has been used during this rulemaking to refer to provisions which were required by former § 1910.309(a) (and by proposed § 1910.302(b)(1)) to be implemented without regard to when the electrical installation was made. OSHA recognizes that this is an unorthodox use of the term "retroactive," since these provisions do not involve retroactivity in the true sense of the word. The so-called "retroactive" provisions of § 1910.309(a) required certain previously installed equipment to be updated as of the standard's effective date to meet a list of requirements from the 1971 NEC. In that sense, its application to existing installations was no different than that of the other national consensus standards which OSHA adopted under section 6(a) of the Act. In other words, employers who had not voluntarily met these standards before OSHA adopted them were now required to bring their facilities into compliance.

In this preamble, OSHA will refer to the requirements of § 1910.309(a) and proposed § 1910.302(b) as the "retroactive" provisions of Subpart S, in order to avoid further confusion, even though the term is not accurate.

Similarly, § 1910.309(b) (and proposed § 1910.302(b)(2)) which apply the entire electrical standard to installations made after March 15, 1972, are referred to as the "grandfathering" provisions, because they did not require that installations made before March 15, 1972, comply with the entire 1971 NEC (or as stated in § 1910.302(b)(2), comply with all of Subpart S).

b. *Background of the former § 1910.309*

OSHA's former General Industry Electrical Safety Standard included §§ 1910.309 (a) and (b), which read as follows:

(a) The requirements contained in the following articles and sections of the National Electrical Code, NFPA 70–1971; ANSI C1–1971 (Rev. of C1–1968) shall apply to all electrical installations and utilization equipment: [4 articles and 74 provisions of the 1971 NEC were listed].

(b) Every new electrical installations and all new utilization equipment installed after March 15, 1972, and every replacement, modification, or repair or rehabilitation, after March 15, 1972, of any part of any electrical installation or utilization equipment installed before March 15, 1972, shall be installed or made, and maintained, in accordance with the provisions of the 1971 National Electrical Code, NFPA 70–1971; ANSI C1–1971 (Rev. of C1–1968).

Under these provisions, the 4 articles and 74 provisions of the 1971 NEC, as listed in § 1910.309(a), applied to all electrical installations and utilization equipment, including those installed before the rule was published. If these installations and equipment did not comply with the listed provisions, they were required to be brought into compliance. Paragraph 1910.309(b), then, provided that equipment and

installations made after March 15, 1972, were subject to the entire 1971 NEC.

To the extent that § 1910.302(b) of the proposal was developed directly from these provisions, OSHA believed that it was clear that no new requirements were proposed for installations and equipment installed prior to March 15, 1972. In fact, the list of provisions in proposed § 1910.302(b)(1) was shortened, and the listed provisions were simplified significantly from those in § 1910.309(a).

However, as the rulemaking on Subpart S progressed, it became evident that there was considerable confusion over proposed § 1910.302(b)(1) and its antecedent, § 1910.309(a). Some parties contended that proposed § 1910.302(b)(1) actually added new "retroactive" requirements not found in § 1910.309(a). Others indicated that they did not understand either the proposed or the existing "retroactive" provisions. In this regard, OSHA believes that it will be helpful at this point to discuss the development of § 1910.309 as it has appeared in Subpart S since 1972.

On May 29, 1971, OSHA published, under Section 6(a) of the Act, its first package of national consensus and established Federal standards in 29 CFR Part 1910 (36 FR 10466). Various amendments were made less than three months later, on August 13–14, 1971, (36 FR 15101, 15438). Included in the initial package of standards was Subpart S of Part 1910, entitled "Electrical." Certain substantive provisions from the 1968 NEC were published nearly verbatim in Subpart S as § 1910.308 and §§ 1910.310–1910.328. The August 13, 1971 amendments provided that these sections became effective on August 27, 1971 (36 FR 15101). The remaining provisions of the 1968 NEC were incorporated by reference in § 1910.309, and employers were given an additional 5½ months, until February 15, 1972, to adjust to and come into compliance with these requirements.

However, before the expiration of the two year period established by section 6(a) of the Act for the adoption of national consensus standards as OSHA standards, the NFPA issued its 1971 edition of the NEC. The 1971 NEC thus became the latest edition of the national consensus standards for electrical safety. OSHA reviewed its existing standards and determined that there were potential conflicts between the two consensus standards, namely, the 1968 NEC and 1971 NEC. Under section 6(a) of the Act, the Assistant Secretary eliminated such conflicts by promulgating the standard which assured the greatest protection for employees.

OSHA determined that original §§ 1910.310–1910.328, as originally promulgated, were necessary elements of employee safety in existing installations, and that their coverage should be continued for all electrical installations, regardless of when made. It was also determined that for future installations and modifications of existing installations, the entire 1971 NEC should be applicable.

For existing installations, then, OSHA adopted only the Articles and Sections of the 1971 NEC which, in their 1968 versions, had been the sources for original §§ 1910.310–1910.328 (37 FR 3431, February 16, 1972). Where there was conflict between the 1968 provisions and the 1971 provisions, section 6(a) of the Act required the adoption of the version which "assures the greatest protection of the safety or health of the affected employees." (29 USC 655(a).) The Assistant Secretary selected the 1971 versions as being more protective than those of 1968. (This determination was also congruent with the NFPA's own determination, as stated in a new provision of the 1971 NEC, Section 90–1, that the 1971 Code contained "requirements considered necessary for safety.")

OSHA did not then publish sections 1910.308 and 1910.310–1910.328, taken from the 1971 Code, to replace those sections originally taken from the 1968 Code. Instead of publishing the text of these NEC articles and sections verbatim within Subpart S, OSHA chose to list them and incorporate them by reference in paragraph (a) of § 1910.309 and apply them to all electrical installations. Paragraph (b), on the other hand, incorporated the entire 1971 NEC by reference for application only to installations, modifications, repairs, and renovations made after March 15, 1972 (37 FR 3431, Feb. 16, 1972).

The format and content of § 1910.309, as promulgated in February 1972 has remained unchanged since then, except for the revision of a requirement from the 1971 NEC relating to ground-fault protection on construction sites.

It is clear from this discussion that OSHA's actions in applying only certain provisions of the 1971 NEC to existing installations were well within the authority of the Assistant Secretary under section 6(a) of the Act. Indeed, the promulgation of former § 1910.309 did not constitute the fullest possible exercise of section 6(a) authority, which could have resulted in the entire 1971 NEC being applied to all electrical installations. The Assistant Secretary acted to resolve the conflict between consensus standards in a manner which did not compromise the good faith efforts of employers to comply with the electrical standards as originally promulgated.

c. *Background of proposed § 1910.302(b)*

OSHA proposed to retain most of the requirements of former § 1910.309 in proposed § 1910.302(b). The proposed provision retained the dichotomy between old and new installations as contained in § 1910.309, as follows:

(b) *Extent of application.* (1) The requirements contained in the sections listed below shall apply to all electrical installations and utilization equipment regardless of when they were designed or installed: [28 sections of proposed Subpart S were listed, containing 46 provisions].

(2) Every new electric utilization system and all new utilization equipment installed after March 15, 1972, and every replacement, modification, repair, or rehabilitation, after March 15, 1972, of any part of any electric utilization system or utilization equipment installed before March 15, 1972, shall be installed or made, and maintained, in accordance with the provisions of §§ 1910.302 through 1910.308 of this subpart.

The requirements listed in proposed § 1910.302(b)(1) were all based on the 1971 NEC Articles and Sections contained in the former § 1910.309(a) list. Some of the requirements in the old list were proposed to be deleted (e.g., NEC Section 422–17). Others were written in more performance-oriented terms (e.g., NEC Articles 500, 501, 502, and 503), allowing alternative methods of compliance to those specified in the 1971 NEC. (These changes are noted in detail in section IV of this preamble.) Thus, the proposal provided much greater flexibility for the employer than did the former regulation.

The "retroactive" provisions in proposed § 1910.302(b)(1) related to such critical areas as grounding, guarding live parts, use of flexible cords, overcurrent protection, hazardous locations, identification of equipment and disconnecting means, and inspection of equipment. In evaluating the need for these requirements, OSHA reviewed 1971 and 1972 electrical accident data from the State of California. From this data, OSHA concluded that 70 percent of the electrical accidents which were attributable to unsafe conditions involved hazards addressed by the "retroactive" requirements.

Most of the comments and testimony introduced on the issue of the "retroactive" provisions were submitted by representatives of a single industry, involving feed and grain production (Tr. 168–169, 250–251, 264–269, 420; Ex. 19, 21, 28, 31, 32, 39, 54). Some argued that OSHA's former regulation was not recognized by industry as applying "retroactively" and that OSHA

compliance officers were interpreting it inconsistently (Ex. 31, 44).

However, the record clearly indicates that the "retroactive" provisions of § 1910.309(a) have been uniformly applied by OSHA to installations made prior to March 15, 1972. This fact is indicated by the evidence of citations submitted into the record (Ex. 55G). In addition, testimony of representatives from organizations such as the American Petroleum Institute, Underwriters Laboratories, Inc., and the National Fire Protection Association shows that industry in general has been well aware of the "retroactive" provisions of § 1910.309(a) during the nearly nine years since their original promulgation (Tr. 307, 324, 408–409).

Furthermore, the Occupational Safety and Health Review Commission, in *Delaware and Hudson Railway* (1980 OSHD ¶ 24,422), has ruled definitively that the "retroactive" provisions of § 1910.309(a) do apply to equipment installed before March 15, 1972. As the Commission noted:

> Respondent submits that section 1910.309(b) limits the application of section 1910.309(a) to equipment installed after March 15, 1972.
>
> Sections 1910.309 (a) and (b) must be read together. Section 1910.309(a) incorporates by reference certain specified sections of the NEC as occupational safety and health standards and provides that they "shall apply to *all* electrical installations. . . ." (emphasis added). Section 1910.309(a) contains no clause excluding previously installed equipment from its coverage. Section 1910.309(b), on the other hand, goes further than section 1910.309(a)'s incorporation of only specific sections of the NEC, and requires compliance with the entire electrical code. The terms of section 1910.309(b), however, limit its application to equipment installed, replaced, repaired, or rehabilitated after March 15, 1972. Because Respondent was cited for a failure to comply with an NEC provision specifically incorporated in section 1910.309(a), the date of installation of Respondent's equipment is irrelevant. (1980 OSHD ¶ 24,422, at p. 29787).

Several commenters argued that even if § 1910.309(a) by its terms applies to installations made prior to March 15, 1972, the NEC was not intended by its drafters to be applied "retroactively" in this way, but was only intended to be used prospectively, as an installation standard (Ex. 31, 32, 54, 69). These commenters argued that there was no evidence in the record that any other State or governmental agency had adopted the NEC "retroactively."

The 1971 NEC was totally silent on the question of its application to existing facilities. Had the drafters intended to limit its application to new installations, they could easily have included a statement to that effect in the scope provisions (Section 90–2) of the Code. (In fact, the NEC Code Making Panel which is responsible for the scope and introduction to the NEC rejected a proposal for the 1975 NEC which would have provided an exemption for existing installations. See pp. 1–3, *Preprint of the Proposed Amendments for the 1974 National Electrical Code*, Part II (NFPA, 1973).) Moreover, the 1971 NEC clearly indicated an intention to leave all such questions of application and enforcement to the enforcing authority. For example, section 90–7 provided:

> This Code is intended to be suitable for mandatory application by governmental bodies exercising legal jurisdiction over electrical installations. . . . The administrative authority supervising such enforcement of the Code will have the responsibility for making interpretations of the rules, for deciding upon the approval of equipment and materials, and for granting the special permission contemplated in a number of the rules.

In addition, section 90–1(b) of the 1971 NEC did not distinguish between safety in existing installations and safety in new installations:

> This code contains provisions considered necessary for safety. Compliance therewith and proper maintenance will result in an installation essentially free from hazard. . . .

Thus, the 1971 NEC contained no provisions which indicated an intent for that Code to apply only to new electrical installations. The question of how the Code would be applied was left to the authorities enforcing it, including OSHA.

Section 6(a) of the Act was enacted to provide protection to employees from workplace hazards as soon as possible. The urgency of this action was underscored by Congress' authorization to OSHA to proceed without regard to the rulemaking procedures of the Administrative Procedure Act (5 U.S.C. 553). Had OSHA chosen to apply the 1971 NEC only to new installations, such action would not have resulted in any improvement in employee safety under existing conditions. Furthermore, there would have been no coverage at all for these conditions.

OSHA's selection of provisions from the 1971 NEC to apply to all installations represented a means of complying with the letter and the spirit of section 6(a) of the Act. Virtually all of the "retroactive" provisions in former § 1910.309(a) (and, necessarily, in proposed § 1910.302(b)(1)) had been in the NEC in one form or another for many years prior to the 1971 edition. Hence, although they were now mandatory on a National scale for the first time, these provisions were already well known to employers across the country.

It is important to note that former § 1910.309(a) listed only a small portion of the 1971 NEC for application to installations made before March 15, 1972. Additionally, the overwhelming majority of these provisions originated in editions of the NEC dated 1937 or earlier (see Table following).

Table of "Retroactive" Provisions

"Retroactive" provisions in OSHA's former standards (§ 1910.309(a))		NEC edition and page numbers in which provisions first appeared	Provisions not "retroactive" in OSHA's proposal (§ 1910.302 (b)(1))
Sections:			
250-58 (a) and (b)	Equipment on Structural Metal	1930, p. 125	X
250-59 (a), (b), and (c)	Portable and/or Cord Connected and Plug Connected Equipment, Grounding Method.	1930, p. 132; 1935, p. 138; 1937, p. 65.	X
400-3 (a) and (b)	Flexible Cords and Cable, Uses	1930, p. 132; 1937, p. 127	
400-4	Flexible Cords and Cable Prohibited	1959, p. 206	
400-5	Flexible Cords and Cables, Splices	1947, p. 131	
400-9	Overcurrent Protection and Ampacities of Flexible Cords.	1930, p. 83; 1937, p. 127	
400-10	Pull at Joints and Terminals of Flexible Cords and Cables.	1930, p.82	
422-8	Installation of Appliances with Flexible Cords	1930, p. 70	X
422-9	Installation of Portable Immersion Heaters	1935, p. 182	X
422-10	Installation Appliances Adjacent to Combustible Material.	1935, p. 182	X
422-11	Stands for Portable Appliances	1935, p. 182	X
422-12	Signals for Heated Appliances	1935, p. 182	X
422-14	Water Heaters	1956, pp. 70-181	X
422-15 (a), (b), and (c)	Installation of Infrared Lamp and Industrial Heating Appliances.	1947, p. 144	X
110-14 (a) and (b)	Electric Connection	1930, p. 14; 1935, p. 16	
110-17 (a), (b), and (c)	Guarding of Live Parts	1936, p. 19	
110-18	Arcing Parts	1937, p. 20	
110-21	Marking	1937, p. 20; 1899, pp. 10, 22, 33, 43.	
110-22	Identification	1965, p. 16	
240-16 (a), (b), (c), and (d)	Location in Premises (for Overcurrent Protection Devices).	1930, p. 100	
240-19 (a) and (b)	Guarding of Arcing or Suddenly Moving Parts of Overcurrent Protection Devices.	1930, p. 98	
250-3 (a) and (b)	D.C. System Grounding	1930, p. 137; 1925, p. 85	
250-5 (a), (b), and (c)	A.C. Circuits and Systems. To be Grounded	1930, pp. 127-128; 1925, p. 85.	
250-7	Circuits not to be Grounded	1936, p. 57	X
250-42 (a), (b), (c), and (d)	Fixed Equipment Grounding, General	1930, p 130; 1937, p. 58	
250-43 (a), (b), (c), (d), (e), (f), (g), (h), and (i).	Fixed Equipment, Grounding, Specific	1930, p. 130, 1937, pp. 58-59.	X
250-44 (a), (b), (c), (d), and (e).	Nonelectrical Equipment, Grounding	1930, p. 131; 1937, p. 60	
250-45 (a), (b), (c), and (d)	Equipment Connected by Cord and Plug, Grounding.	1930, p. 132	
430-142 (a), (b), (c), and (d)	Stationary Motor, Grounding	1937, p. 158	X
430-143	Portable Motors, Grounding	1937, p. 159	X
250-50 (a) and (b)	Equipment Grounding Connections	1947, p. 65	
250-51	Effective Grounding	1937, p. 63	
250-57 (a) and (b)	Fixed Equipment. Method of Grounding	1937, p. 65	
422-16	Appliance Grounding	1937, p. 138	X
422-17	Installation of Wall-mounted Ovens and Counter-mounted Cooking Units.	1937, p. 137, 139	X
Articles:			
500	Hazardous Locations		
501	Class I Installations (Hazardous Locations)	1925; 1928; 1930, p. 185	
502	Class II Installations (Hazardous Locations)		
503	Class III Installations (Hazardous Locations)		
"Approval Requirements"[1]		1899, pp. 6, 20, 26, 27, and 29 supplement.	

[1] The general approval requirement is not "retroactive" either in OSHA's present or proposed regulations. It is shown here to indicate its genesis.

Lastly, several commenters claimed that "retroactive" application of OSHA's electrical standards would result in a vast economic burden on employers without being necessary for employee safety (Tr. 169–171; Ex. 31, 56, 61, 62). To support their claim, two organizations submitted economic impact studies on their respective industries (Ex. 55J, 58).

As discussed more fully in the section on regulatory assessment (Section V), the exaggerated cost estimates in these industry studies can be attributed to a lack of clarity and proper organization in § 1910.307 as proposed. During the rulemaking, as is later noted, proposed § 1910.307 was viewed by various parties as imposing an "approval" requirement for electrical equipment in hazardous locations. This section applied to all such equipment, regardless of when installed, by virtue of its inclusion in the "retroactive" list in § 1910.302(b)(1). Thus, based upon this interpretation, the cost estimates in the industry studies included the unnecessary and enormous expense of removing acceptable equipment which was not "approved."

OSHA recognizes that proposed § 1910.307, as drafted, may have been susceptible to such reading. However, as

issue 4 in this section of the preamble makes clear, it was never OSHA's intention to require "approval" or "listing" or "labeling" of equipment in hazardous locations installed before March 15, 1972. Approval of this sort was only one of three alternatives which OSHA intended to allow for these locations. Although approval of equipment is certainly an acceptable means of compliance, § 1910.307 provides that other equipment will also be acceptable if it is intrinsically safe or if the employer can demonstrate that the equipment is of a type and design which provides protection from the hazards of the hazardous location. This performance requirement is, if anything, a less burdensome provision than the requirements from the 1971 NEC which have been enforced under § 1910.309(a).

Thus, many of the costs submitted in the industry studies are not imposed by the revision of Subpart S. The reorganization of § 1910.307 in the final standards will help to clarify the situation and remove the cause of the controversy surrounding both this section and the other "retroactive" provisions of § 1910.302(b)(1).

OSHA has considered the recommendations for eliminating "retroactive" provisions for older electrical installations and has concluded that a total exemption of all existing facilities is unwarranted. "Retroactive" application of the requirements listed in § 1910.302(b)(1) has been shown to be reasonably necessary for employee safety and has not been shown to be an unwarranted or extremely costly burden on employers. Therefore, § 1910.302(b)(1) has been adopted with no change from the proposal.

4. *Whether the marking and approval requirements in proposed §§ 1910.303(a), 1910.303(e), and 1910.307(b)(4) deviate from the existing regulations and whether they relate to employee safety.*

a. *Marking*

OSHA's previous standards on the general marking of electrical equipment were contained in 1971 NEC Sections 110–21 and 500–2(b). In the former standards, both requirements were "retroactive," and they read as follows:

110–21. *Marking.* The manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the product may be identified, shall be placed on all electrical equipment. Other markings shall be provided giving voltage, current, wattage, or other ratings as are prescribed elsewhere in this Code. The marking shall be of sufficient durability to withstand the environment involved.

500–2. *Special Precaution.* * * *

(b) *Marking.* Approved equipment shall be marked to show the Class, Grqup and operating temperature, or temperature range, based on operation in a 40° C ambient for which it is approved.

The temperature range, if provided, shall be indicated in identification numbers, as shown in Table 500–2(b).

Identification numbers marked on equipment nameplates shall be in accordance with Table 500–2(b).

Exception: Equipment of the nonheat-producing type, such as junction boxes, conduit and fittings, are not required to have a marked operating temperature.

OSHA proposed to retain both provisions, with some minor modifications. Paragraph 1910.303(e) proposed requirements equivalent to NEC Section 110–21, except with the words "as are prescribed elsewhere in this Code" changed to the more performance-oriented "as may be required." In proposed § 1910.307(b)(4), the second and third sentences of NEC Section 500–2(b) were deleted, a related sentence from 1971 NEC Section 500–2(c) was added, and two new exceptions were also added. These changes resulted in no new obligations for employers.

Some commenters were concerned with the "retroactive" application of the general marking requirements, § 1910.303(e) (Tr. 309, 396–397; Ex. 19, 31). However, it must be noted that this requirement was not new to the NEC when the first OSHA electrical standards were promulgated. Indeed, this requirement can be found as far back as the 1918 National Electrical Code,[1] and it has been carried forward in all subsequent editions. More than half a century later, it was reasonable for OSHA to expect that most, if not all workplaces were in compliance with this provision when Subpart S was first promulgated.

The commenters also suggested that marking was not related to employee safety. However, since the required markings provide for proper identification and utilization of equipment, the requirement clearly provides protection for operating and maintenance personnel (Tr. 64, 73–74).

One commenter (Ex. 56) was concerned that otherwise safe equipment would have to be replaced for lack of the required markings and suggested that OSHA allow the employer to mark the equipment. In this regard, the standard does not specify that markings are only acceptable if they are part of the manufacturers' nameplates (though a nameplate would be acceptable). The standard allows the employer to place the required marking on equipment provided that it is done in a manner which ensures sufficient durability.

Many of the comments on OSHA's proposal, as well as some of the hearing exhibits, reflected misinterpretations of OSHA's marking requirements (Exs. 2, 19, 21, 31). The terms "marking", "labeling", and "approval", each of which has its own distinctive meaning within the context of Subpart S, were nonetheless used interchangeably by the commenters and witnesses. In this regard, it may be helpful to discuss the meanings of and relationships between these terms in the context of the standards.

"Marking" means no more than the identification of the key electrical parameters of a piece of electrical equipment. As noted above, § 1910.303(e) does not require that this "marking" take the form of a manufacturer's nameplate. Marking may be accomplished by any means which will provide the necessary information and will be capable of withstanding the operating environment of the equipment.

"Marking" does not mean the same thing as "labeling", as used in both the NEC and Subpart S. "Labeling" refers to the label of a nationally recognized testing laboratory, such as Underwriters Laboratories, Inc. (UL), or Factory Mutual Engineering Corporation, which indicates that the equipment in question has met criteria set by that laboratory for electrical safety. "Labeling," unlike "marking," is not required by Subpart S; however, if equipment is required by the Subpart to be "approved," equipment which is "labeled" is acceptable to OSHA.

The general requirement that all equipment be "approved", which was carried forward in proposed § 1910.303(a), only applies to installations made after March 15, 1972. This requirement was not contained in the list of "retroactive" provisions in former § 1910.309(a) and was also not contained in the list of proposed § 1910.302(b)(1). (See discussion of *Approval* in Section III, Issue 4b of this preamble.)

In brief, the general requirements for marking in § 1910.303(e) apply to all electric equipment; the general approval requirement in § 1910.303(a) applies to equipment installed after March 15, 1972; and there is no labeling requirement. If equipment is required to be "approved", unapproved equipment generally has to be replaced with "approved" equipment. On the other hand, equipment which is not properly marked need not be replaced but need

[1] P. 128 (Class D, Markings) 1918 "National Electrical Code", *Regulations of the National Board of Fire Underwriters for Electric Wiring and Apparatus, as Recommended by the National Fire Protection Association.*

only be marked with the necessary information.

Other commenters addressed § 1910.307(b)(4). They claimed that this paragraph required unnecessary marking of dust-tight equipment, which did not need to be marked for use in Class II, Division 2 locations (Tr. 274–275; Ex. 19, 34, 56). To support their views, they cited the 1981 NEC which has clarified the marking requirement by including an exception to Section 500–2(b) for dust-tight equipment in Class II, Division 2 and Class III locations. So that OSHA's standard would not conflict with the NEC, they suggested that § 1910.307(b)(4) be changed to read as follows:

(4) *Marking.* Approved equipment not covered in paragraphs (b)(4)(i) through (b)(4)(iv) of this section shall be marked to show the class, group, and operating temperature, or temperature range, based on operation in a 40° C ambient, for which it is approved. The temperature marking shall not exceed the ignition temperature of the specific gas or vapor to be encountered.

(i) 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), shall not be required to have a marked operating temperature or temperature range.

(ii) Fixed lighting fixtures marked for use in Class I, Division 2 locations only, need not be marked to indicate the Group.

(iii) Fixed general purpose equipment in Class I locations other than fixed lighting fixtures which is acceptable for use in Class I Division 2 locations shall not be required to be marked with the Class, Group, Division or operating temperature.

(iv) Fixed dust tight equipment other than fixed lighting fixtures which are acceptable for use in Class II Division 2 and Class III locations shall not be required to be marked with the Class, Group, Division or operating temperature.

The proposed version allowed general-purpose equipment suitable for any Division 2 location to be unmarked. Since dust-tight equipment was acceptable for installation in Class II, Division 2 locations, proposed § 1910.307(b)(4)(iii) already accepted the use of unmarked, dust-tight equipment in Class II, Division 2 locations. However, in an effort to clarify this point and in agreement with the comments received, the suggested change has been included in the final rule.

b. *Approval*

OSHA's former regulation requiring all equipment to be approved was contained in 1971 NEC Section 110–2, which was not made applicable to equipment installed before March 15, 1972. Definitions and clarifications relating to approval were contained in former § 1910.308(d), and paragraph (d)(1) stated that approved meant "acceptable to the Assistant Secretary of Labor for Occupational Safety and Health." For the purpose of the former regulations, § 1910.308(d)(2) listed the types of installations or equipment which would be acceptable (and therefore "approved"). The definitions applied both to the general approval requirement and to provisions of the 1971 NEC which contained their own specific approval requirements.

In proposed § 1910.303(a), OSHA retained the same approval requirement as that contained in 1971 NEC Section 110–2. The definitions relating to approval were also retained. In keeping with the former standards, § 1910.303(a) was not proposed to be made applicable to equipment installed before March 15, 1972. However, § 1910.307 (dealing with equipment installed in hazardous locations) was proposed to be made applicable to all electric equipment. This proposed section corresponded to Articles 500–503 of the 1971 NEC, which were listed in § 1910.309(a) of the former standards as being "retroactive." Proposed § 1910.307 did contain some requirements relating to approval of equipment. In paragraph (c), this section required equipment to be one or more of the following: (1) intrinsically safe, (2) approved for the hazardous location, or (3) of a type and design which provides protection from the hazards arising from the combustibility and flammability of vapors, liquids, gases, dusts or fibers.

Equipment "approval" was intended to be only one means of compliance. Paragraphs (b)(1) and (b)(2) were not intended to establish substantive requirements unless the employer selected the means of compliance in § 1910.307(c)(2). Since they related only to approval, these paragraphs were not applicable if one of the other two methods of compliance were chosen.

There seemed to be confusion among the commenters about these approval requirements (Tr. 294; Ex. 31, 49). One assumed that the proposal required all equipment in hazardous locations to be approved regardless of when it had been installed and claimed that retrofitting of existing equipment would be required solely because such equipment was not approved (Ex. 56). The extent of the confusion is indicated by the testimony of one witness who believed that U.L. listed motors built between 1973 and 1975 would have to be replaced, because Underwriters Laboratories subsequently changed their standards (Tr. 275–276).

However, OSHA does not intend to require all equipment in hazardous locations to be "approved." Although hazardous locations are required to comply with § 1910.307, the approval requirement contained therein is only one of the three alternate methods by which employers can comply. The standard does not require existing equipment to be "approved," as long as the employer can demonstrate that it is safe for the hazardous location.

OSHA intended the requirements for approved and intrinsically safe equipment, as set forth in proposed paragraph (b) of § 1910.307 to be read totally in the context of the alternatives for compliance under paragraph (c) of that section. Thus, if an employer chose to comply with § 1910.307 by using approved or intrinsically safe equipment in hazardous locations, the requirements applicable to such equipment in paragraph (b) would specify what each compliance option entailed.

The general approval requirements in § 1910.303(a), then, do not apply to installations made before March 15, 1972. Therefore, that section does not require any changes to an employer's equipment if that equipment was installed before March 15, 1972. Additionally, with respect to the approval-related options contained in § 1910.307, OSHA has reorganized the final rule to state the agency's intent more clearly. Section 1910.307 requires that equipment in hazardous locations be one or more of the following: (1) intrinsically safe (§ 1910.307(b)(1)); (2) approved for the hazardous location (§ 1910.307(b)(2)); or (3) of a type and design which provides protection from the hazards arising from the combustibility and flammability of vapors, liquids, gases, dusts, or fibers (§ 1910.307(b)(3)). Requirements addressing each alternative set forth in § 1910.307 have been relocated to show that they apply only to that alternative. For example, if the employer selects to use approved equipment as a means of complying with § 1910.307(b), then new § 1910.307(b)(2)(i) indicates that such equipment must be approved not only for the Class and Division but also for the group of atmosphere involved.

5. *Whether the impedance and ampacity requirements of National Electrical Code (NEC) Section 250–51 should be included in the standard.*

Section 1910.304(f)(4) of the proposed electrical standards, which requires that the path to ground from circuits, equipment, and enclosures be permanent and continuous, was derived from Section 250–51 of the 1978 NEC. However, it does not contain the ampacity and impedance requirements of the grounding path which are in both the 1978 NEC (Section 250–51) and the former OSHA standards.

The proposed requirements of § 1910.304 specify that conductors and equipment be protected in accordance with their ability to safely conduct current, and § 1910.305 requires that wiring methods, components, and equipment for general use be approved for the purpose. It follows that if these two performance requirements are met, then all basic requirements applicable to ampacity and impedance will likewise be satisfied. For this reason, the ampacity and impedance requirements are omitted here without affecting employee safety. These changes reflect the general approach to simplify and clarify the proposed standard.

The record reflects general agreement that deletion of the ampacity requirement was justified (Ex. 22; Tr. 94, 398). The ampacity requirement of NEC Section 250–51 should be satisfied at the time of initial installation of the electrical utilization equipment or systems in which the equipment grounding conductors are a part.

There was considerable testimony plus comment in the record, however, on the proposed deletion of the impedance requirement. It was contended that the omission of this requirement would reduce the protection of employees against shock and electrocution. To achieve employee protection against shock and electrocution, it was argued the equipment grounding conductor must not only have continuity, it must also present a low impedance path which will permit sufficient fault current to flow thus assuring the rapid operation of the overcurrent device protecting the circuit (Ex. 22).

The same commenter, however, further indicated that a return to the impedance requirements of NEC 250–51 would still be inadequate because the quality of the equipment ground is generally an unknown value and requires verification. For example, NEC 250–51 paragraph (c) specifies no quantitative values but requires only that the grounding path have "sufficiently low impedance" to limit the voltage to ground and to facilitate the operation of the circuit protective devices in the circuit. Thus, the NEC specifies the ground path requirements in terms of performance and does not specify values of impedance. The commenter recommended (Ex. 22) that OSHA change the proposed § 1910.304(f)(4) to read as follows: "The path to ground from circuits, equipment and enclosures shall be permanent, continuous and have sufficiently low impedance to limit the voltage to ground and to facilitate the operation of the circuit protective devices in the circuit. The impedance of this path shall not exceed the levels given in Table S–4." (Table S–4 is contained in Exhibit 22 and specifies a maximum equipment ground impedance for different overcurrent device ratings at various circuit voltages.)

Mr. Robert West, an expert in the area of electrical grounding and its relationship to occupational safety standards, stated at the hearing (Tr. 113) that the impedance of equipment grounding conductors for most of the circuits in many operational workplaces cannot be accurately verified by testing. The reason for this is that the test current will flow in unknown conducting paths that are in parallel with the equipment grounding conductors. The witness cited (Tr. 110) examples of test situations which could occur with commercial testers showing the presence of a low impedance equipment grounding conductor when, in fact, the equipment grounding conductor is disconnected. Because of these problems, it was Mr. West's view that the standard should not require impedance testing. Mr. West indicated (Tr. 113) that the requirement for the path to ground from circuits, equipment, and enclosures to be permanent and continuous can be verified in most operational workplaces by visually inspecting grounding conductors and by checking the grounding conductor connections for tightness.

A representative of Monsanto Company (Tr. 337) also agreed with OSHA's deletion of the impedance requirement and submitted the results of a series of field tests performed to evaluate a particular equipment grounding conductor impedance measuring technique (Ex. 36). According to this witness, the tests were conducted to determine whether or not meaningful values of equipment grounding conductor impedance could be obtained through measurements using a commercially available tester designed for this purpose. The test results showed generally how the existence of parallel paths affect the measurement of equipment grounding conductor impedances. One significant test result was that impedance measurements will not always reveal a break (open conductor) in, or the absence of, the equipment grounding conductor.

In one instance, one commenter submitted what appeared to be inconsistent testimony concerning impedance testing. The initial submittal (Ex. 22) stated: "Instrumentation is commercially available that will quickly, easily and accurately measure the impedance of *only the equipment grounding conductor* under live circuit conditions" (emphasis added). However, in his post-hearing comment, the same commenter concluded that the impedance tester would not be able to measure the impedance of the conductor alone, but would only be able to measure the impedance of the total fault path: "The purpose of the impedance tester is to accurately determine the amount of impedance *in the anticipated fault path whether it is called an equipment grounding conductor or anything else*" (Ex. 68A) (emphasis added).

Where non-current-carrying metal parts of electrical equipment are required to be grounded, § 1910.304(f) specifies that only equipment grounding conductors be used and that the equipment grounding conductor must be installed either along with the circuit conductors or enclose the circuit conductors. The reason for keeping the ground return path and the phase legs in close proximity is to minimize the impedance of the fault circuit by placing conductors so their magnetic fields cancel each other and mutual inductance is minimized. This reduces the inductive reactance and allows sufficient current to flow, thus facilitating operation of the circuit protective devices.

Where conduit is used as an equipment grounding conductor, the ground-fault current flows through a conductor inside the conduit and returns through the conduit. When this occurs, practically all of the magnetic field is inside the conduit. This results in practically all of the inductive reactance of the circuit appearing on the inside conductor while the impedance of the conduit becomes approximately equal to its DC resistance.

Low resistance paths in parallel with the equipment grounding conductor will carry some portion of the total ground-fault current. These unknown and undefined parallel paths make it impossible to separate and measure the impedance of only the equipment grounding conductor alone.

Tests have shown that ground path impedance measurements involving extraneous parallel paths can give incorrect indications regarding disconnected or open grounding conductors (Ex. 17, 36). Under these conditions, as noted above, impedance measurements may not detect the presence of serious electrical hazards. They may well give the employee a false sense of security as to the safety of an installation. With limitations of this type, it appears that visual inspection and periodic maintenance are the only practical approach to assure a safe

condition of the equipment grounding conductor.

Additionally, one commenter (Ex. 22) referenced accident data involving electrical work injuries in California (1972) and claimed that a major factor contributing to the injuries was equipment not being grounded or having poor or inadequate grounding connections. A review of the actual accident descriptions, however, indicated the presence of such other causal factors as the total absence of proper equipment grounding means, interruption in the continuity of the equipment grounding conductor, or improper connection of grounding conductors. The data did not, therefore, indicate that the ohmic value of the equipment grounding conductor impedance was a significant factor in the accidents.

Grounding path resistances are usually determined in the design stage of equipment and electrical installations and are not intended to be measured in the field on a routine basis. OSHA's recognition of this fact has previously been incorporated into the OSHA standard on ground-fault protection (§ 1926.400(h) is the cognizant standard), where only a continuity test of the equipment grounding conductor is required. A quantitative test including an ohmic value is not considered necessary or appropriate for determining the presence of the equipment grounding conductor.

It is OSHA's belief that equipment grounding systems, installed in accordance with the requirements of this Subpart, will significantly reduce the chances for personnel injuries provided the continuity and permanence of the equipment grounding conductors and connections are maintained after the systems are placed in operation.

The path to ground from circuits, equipment and enclosures can usually be verified as being permanent and continuous by an inspection of equipment grounding conductors and the grounding conductor connections. In certain special cases, where extraneous parallel paths are not a problem, continuity tests can also be made to verify the presence and integrity of equipment grounding conductors. OSHA recognizes that impedance testing may lead to false assurances of the impedance, or even the very presence of the grounding conductor. Therefore, for this reason and since maintenance requirements are not the subject of this rulemaking, OSHA is not requiring such testing in these standards.

6. *Whether the prohibition of the use of structural metal frames of buildings as the equipment grounding conductor (1978 NEC 250–58(a)) should be included in the standard.*

The comments addressing this issue refer to proposed § 1910.304(f)(6), dealing with methods of grounding fixed equipment. Specifically, the comments concern the use of structural metal frames of buildings as equipment grounding conductors for AC equipment. Such use is permitted in the 1971 NEC and was carried forward in the proposed standard.

One commenter (Ex. 22) cited the 1978 NEC (Section 250–58) which explicitly states that this use is not acceptable, and argued that a similarly explicit statement should be included in the proposed OSHA standard.

It is noted that although the building of structural metal will, in many installations, possess sufficient ampacity to safely conduct ground-fault currents, the NEC no longer considers such a grounding path to be a valid substitute for the required equipment grounding conductor. The code's current position is that there is always the possibility that any path to ground other than the equipment grounding conductor may have insufficient capacity. This can result in a serious hazard in those installations where the presence of large-capacity circuits have the capability of producing thousands of amperes of fault-current. Also, where high-magnitude ground-fault currents are forced to flow in paths that are remote from the circuit conductors, magnetic fields are generated which can induce voltages in adjacent conductors. Such induced voltages may cause failure of components in low energy electric systems. Stray ground currents have also been known to cause arcing in piping systems.

On the other hand, from the standpoint of employee safety, installations where electric equipment is secured to, and in metallic contact with, the grounded structural metal 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.

Mr. Robert West suggested that the proposed standard be changed to prevent the structural metal frame of a building from being used as an acceptable equipment grounding conductor for installations made after the date of the final rule (Tr. 115–116). However, he contended that the change should be applicable only to new installations. He noted that prior to the 1978 NEC, Section 250–58 of previous editions, including the 1971 NEC incorporated by OSHA, specifically stated that electrical equipment secured to and in electrical contact with the structural frame of a building was acceptably grounded. Therefore, he argued that it would be impractical to require changes to existing installations.

As a result of the testimony, OSHA has concluded that § 1910.304(f)(6)(ii) should be changed to reflect the latest NEC requirements. This change is accomplished by deleting the first sentence of proposed § 1910.304(f)(6)(ii) and adding two sentences as follows: "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 (f)(6)(i) of this section. For installations made before April 16, 1981 only, electric equipment is considered to be effectively grounded if it is secured to, and in metallic contact with, the grounded structural metal frame of a building."

7. *Whether the definitions for Class II locations and their associated explanatory notes should be changed.*

The proposed definition of a Class II, Division 1 location (§ 1910.399(a)(25)(i)) was identical to the definition in OSHA's previous regulations and read as follows:

> A Class II, Division 1 location is a location: (1) in which conbustible dust is *or may be in suspension* in the air *continuously, intermittently, or periodically* under normal operating conditions, in quantities sufficient to produce explosive or ignitible mixtures; or (2) where mechanical failure or abnormal operation of machinery or equipment might cause such explosive or ignitible mixtures to be produced, and might also provide a source of ignition through simultaneous failure of electric equipment, operation of protection devices, or from other causes; or (3) in which combustible dusts of an electrically conductive nature may be present. (Emphasis added.)

In other words, a location in which a hazardous concentration of combustible dust could be suspended in the air under normal operations was classified as Class II, Division 1.

Contending that the proposed definitions were confusing and would conflict with the 1981 NEC, several grain- and feed-affiliated organizations objected to the proposal (Exs. 18, 19, 21, 31, 32, 39, 49 & 54). Their objections included the following:

(1) The definitions contain vague and improper terminology which requires subjective judgments to be made (Ex. 19).

(2) Code Making Panel 14 of the NEC which is responsible for the content of these definitions in the NEC has changed the definition of Class II hazardous locations in the 1981 National Electrical Code (Ex. 31). Thus, OSHA's proposed definition is inconsistent with the latest NEC.

(3) Hazardous location definitions contained in the proposed 1981 NEC would better identify types of potential hazards through the establishment of performance standards (Ex. 18).

The revised definition as submitted by Panel 14 and accepted for the 1981 NEC reads as follows:

A Class II, Division 1 location is a location: (1) in which combustible dust is *in the air under normal operating conditions, in quantities sufficient* to produce explosive or ignitible mixtures; or (2) where mechanical failure or abnormal operation of machinery or equipment might cause such explosive or ignitible mixtures to be produced, and might also provide a source of ignition through simultaneous failure of electric equipment, operation of protection devices, or from other causes; or (3) in which combustible dusts of an electrically conductive nature may be present. (Emphasis added).

This change would remove the words "or may be in suspension" and "continuously, intermittently, or periodically" from OSHA's former and proposed definitions. However, as stated by an OSHA witness, Dr. Jerry Purswell, Director of Safety Standards, this change "removes the clarification which is needed to realistically describe conditions which are encountered in these locations. Utilizing the proposed 1981 NEC change would permit one to classify a location as a Class II, Division 1 only when dust is actually witnessed, and to disregard the real and frequently existing situations which are presently described in the existing rules" (Tr. 32).

After hearing testimony relative to possible interpretations of the suggested definitions, two members of Code Making Panel 14 who were at the hearing, made the following statements: Mr. Leonard Corey—"After hearing the comments that have been made during this hearing, it would be my recommendation that the panel review this material one more time so that everyone gets a fair hearing on it" (Tr. 410); Mr. Peter J. Schram—"I submit that if the proposed revision of the code is interpreted in this manner [as stated before by Dr. Purswell] the area is not being classified as I intended as a member of Code Panel 14. Had this type of an interpretation been brought up at the meeting or during the voting, I do not believe I would have voted for all of the deletions in Section 500–5(a) of the code for the 1981 edition" (Tr. 464). Since the deadline for commenting on the proposed 1981 NEC had expired, these concerns could not be considered by the NEC Panel before the adoption of the 1981 NEC.

OSHA believes that the deletion of the words "or may be in suspension" would seriously compromise employee safety. It is necessary for the definition to cover not only situations in which explosive or ignitible concentrations of dusts are actually present, but also situations in which such concentrations may arise under normal operating conditions. In this respect, the definition of Class II, Division 1 locations contained in the 1981 NEC represents a potential decrease in employee safety compared to OSHA's former standard, and OSHA has decided not to delete the words "or may be in suspension" from the definitions.

However, based on the comments in the record, the words "continuously, intermittently, or periodically" have been deleted from the definition of Class II, Division 1 locations. For consistency, the language has also been deleted from the definition of Class I, Division 1 locations although most of the comments dealt only with Class II locations. OSHA agrees that these words are possibly confusing and do not enhance the definition.

Therefore, under § 6(b)(8) of the Act, the Assistant Secretary has determined that the 1971 NEC definition of Class II, Division 1 locations, except as noted above, better effectuates the purpose of the Act to provide a safe place of employment than the definition in the 1981 NEC.

The proposed definition of a Class II, Division 2 location (§ 1910.399(a)(25)(ii)) was also identical to the definition in OSHA's previous standards and read as follows:

A Class II, Division 2 location is a location in which combustible dust will not normally be in suspension in the air or will not be likely to be thrown into suspension by the normal operation of equipment or apparatus in quantities sufficient to produce explosive or ignitible mixtures, but: (*a*) Where deposits or accumulations of such combustible dust may be sufficient to interfere with the safe dissipation of heat from electric equipment or apparatus; or (*b*) where such deposits or accumulations of combustible dust on, in, or in the vicinity of electric equipment might be ignited by arcs, sparks, or burning material from such equipment.

Several commenters suggested that OSHA adopt the changes made in the definition of a Class II, Division 2 location in the 1981 NEC (Ex. 19, 32, 55L). They stated that OSHA's adoption of the suggested wording would clarify the difference between Division 1 and Division 2 in Class II locations. The suggested change was as follows:

Class II, Division 2. A Class II, Division 2 location is a location in which (a) combustible dust will not normally be in suspension in the air in quantities sufficient to produce explosive or ignitible mixtures, and dust accumulations are normally insufficient to interfere with the normal operation of electrical equipment or other apparatus; or (b) dust may be in suspension in the air as a result of infrequent malfunctioning of handling or processing equipment, and dust accumulations resulting therefrom may be ignitible by abnormal operation or failure of electrical equipment or other apparatus.

OSHA agrees with these comments and, in view of the absence of any opposition to this change, adopts it in the final standard. Although the wording has been revised, the intent of the definition remains the same and is clearer than that of the proposal, by giving specific examples and by better organization.

The proposed "fine print" notes to the definitions of Class II locations were basically the same as those in OSHA's former regulations (Article 500–5(a) and (b) of the 1971 NEC), and the proposal read as follows:

Class II, Division 1

Note.—This classification usually includes the working areas of grain handling and storage plants; rooms containing grinders or pulverizers, cleaners, graders, scalpers, open conveyors or spouts, open bins or hoppers, mixers or blenders, automatic or hopper scales, packing machinery, elevator heads and boots, stock distributors, dust and stock collectors (except all-metal collectors vented to the outside), and all similar dust-producing machinery and equipment in grain-processing plants, starch plants, sugar-pulverizing plants, malting plants, hay-grinding plants, and other occupancies of similar nature; coal-pulverizing plants (except where the pulverizing equipment is essentially dust-tight); all working areas where metal dusts and powders are produced, processed, handled, packed, or stored (except in tight containers); and all other similar locations where combustible dust may, under normal operating conditions, be present in the air in quantities sufficient to produce explosive or ignitible mixtures.

Combustible dusts which 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 woodflour, oil meal from beans and seed, dried hay, and other organic materials which may produce combustible dust when processed or handled. Electrically conductive nonmetallic dusts include dusts from pulverized coal, coke, carbon black, and charcoal. Dusts containing magnesium or aluminum are particularly hazardous and the use of extreme precaution will be necessary to avoid ignition and explosion.

Several commenters claimed that the proposed fine print note is 25 years old and outmoded and that its emphasis is on types of machinery rather than on types of operation being performed. (Ex. 2, 19, 49, 56). One commenter stated that in many instances, with modern methods of dust control or complete rehandling of the grain or grain product, it is possible that many of the locations noted in the fine print notes would no longer be classified as either Class II, Division 1 or a Class II, Division 2 area (Ex. 49). It was further argued that these notes have been consistently misinterpreted by OSHA compliance officers as firm requirements for classification of locations instead of as guidelines (Ex. 56).

Regarding the explanatory fine print note, OSHA agrees with the comments of the grain and feed industry that the note should reflect the operation being done in the area rather than what equipment is located there. Commenters submitted to the record revised explanatory notes for both Class II, Division 1 and Class II, Division 2 locations (addendum #3). Since these suggested notes more accurately reflect the intent of the definition and describe operations rather than equipment, they have been included, with minor editorial changes, in the final rule. The new notes read as follows:

Class II, Division 1

Note.—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 which 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 ignitible mixtures.

Combustible dusts which 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 woodflour, oil meal from beans and seed, dried hay, and other organic materials which may produce combustible dust when processed or handled. Dust containing magnesium or aluminum are particularly hazardous and the use of extreme precaution will be necessary to avoid ignition and explosion.

Class II, Division 2

This classification includes locations where dangerous concentrations of suspended dust would not be likely but where 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 operation conditions or be adjacent to a Class II, Division 1 location, as described above, into which an explosive or ignitible concentration of dust may be put into suspension under abnormal operating conditions.

8. *Whether installations of electrolytic cells should be covered by the guarding provisions of proposed § 1910.303.*

Section 110–17 of the 1971 NEC, which is referenced in the former regulations, requires live parts of equipment operating at 50 volts or more to be guarded. The 1978 NEC included a new Article 668 which permits electrolytic cells to operate with live parts exposed, provided that specific alternate safety measures are employed.

Electrolytic cells differ in certain respects from standard electrical installations. In a standard electrical circuit, all live parts are required to be insulated or guarded. One side of the circuit is connected to ground to provide a common reference and to stabilize voltages, and thus a potential exists between any live conductor and any grounded surface. A person coming in contact with both a live conductor and a grounded surface will provide a path for electric current to flow and will receive a shock varying in severity with the amount of current that flows through the body. The purpose of the guarding provisions of the NEC is to prevent contact with live parts since contact with grounded surfaces is very common.

In an electrolytic cell line, however, the actual working parts and some working surfaces are, by necessity, the bare live parts of an electric circuit. Employee contact with these live parts is necessary in normal electrolytic cell working procedures. Therefore, whereas a standard circuit necessitates guarding of live parts, employees working on electrolytic cells must be protected against contact with ground. The provisions of Article 668 of the 1978 NEC recognize the different working conditions of electrolytic cell lines and outline the procedures to be used as an alternative to guarding of live parts. The proposed regulations incorporated these electrolytic cell provisions in § 1910.306(h)(3).

Only one commenter (Ex. 20) objected to the provisions proposed in § 1910.306(h)(3). His position was that leaving the energized portions of the cell line unguarded would result in decreased safety protection for workers. To support his position, he cited an electrocution of a worker who died when he stepped into a floor hold and fell against the energized portion of an electrolytic cell. The commenter also state, "The workers typically wear rubber gloves and rubber boots. But if any other portion of the worker's body touches the cell, the worker is electrocuted" (Ex. 20).

As previously discussed, a worker would have to come in contact with both the energized portion of a cell and a grounded surface in order to be electrocuted. The accident referred to resulted when a floor hole was not covered and an otherwise guarded grounded surface was exposed to contact. However, this accident could have happened with a standard electrical circuit if a guard was left off of an energized portion of a conductor, and a worker came in contact with this conductor and a gounded surface.

Ten witnesses (Ex. 23, 24, 29, 38, 40, 41, 46, 51, 52 and 53) appeared in support of the provisions contained in § 1910.306(h)(3). The witnesses included representatives from the aluminum, chlorine, and copper industries. The operations of these industries differ but each requires the actual physical contact with the energized portion of the cell line for proper operation. Various methods of isolating the cell lines from ground were presented, including the insulation of any structural member with wood or fiberglass, and the guarding of grounding parts by distance. The witnesses contended that the addition of guards for the live parts would not enhance employee safety but would actually hinder cell operation and would create a safety hazard by blocking access and egress in emergency siutations. As pointed out at the hearing, if access to the cell is impeded by guards in an emergency situation such as a dry cell, a shorted cell, or an overflow, employees in the area would be subjected to acid burns, electrical flash burns, or injury from flying molten metal (Ex. 40).

The evidence submitted to the record reflects that the alternative procedures being used in cell line operation will provide a safer workplace for electrolytic cell employees than would guarding line parts of cells. In fact, the evidence in the record indicates that guarding live parts of cells may actually reduce employee safety. Therefore, the final rule incorporates the electrolytic cell provisions of § 1910.306(h)(3) as proposed.

IV. Summary and Explanation of the Final Standard

The final standard revising 29 CFR Part 1910, Subpart S, follows the language and format of the proposal with some changes. Most of the changes are editorial in nature. However, those that are substantive are discussed in

detail below. Where changes have been made concerning areas of the proposal which were major issues at the hearing, reference is made to the discussion of such issues in Section III of this preamble. The resulting final standard, which is based on the record considered as a whole, simplifies and clarifies the former Subpart S. The significance of this simplification is indicated by the reduction from the approximately 250,000 words in the National Electrical Code to the approximately 15,000 words in this final standard. As a consequence, the 1971 NEC (NFPA–70) will no longer be incorporated by reference in the OSHA standards.

Subpart S of Part 1910 as revised provides a systematic format both to satisfy present requirements and to accommodate future growth. Subpart S will eventually contain four major parts covering not only the design safety standards for electrical systems contained in this rulemaking (Part I), but also safety-related work practices (Part II), safety-related maintenance requirements (Part III), and safety requirements for special equipment (Part IV).

Some parts of the former §§ 1910.308 and 1910.309 have been deleted. Other parts of these sections have been incorporated into new sections without substantive change. (Any changes made were only editorial to reflect the change in format of the Subpart.) The following table summarizes the numbering changes from the former Subpart S to the final standard:

Redesignation Table

Former paragraph	New paragraph
§ 1910.308(a)	Deleted—unnecessary.
§ 1910.308(b)	Deleted—unnecessary.
§ 1910.308(c)	§ 1910.302(a).
§ 1910.308(d)(1)	§ 1910.399(a)(7).
§ 1910.308(d)(2)	§ 1910.399(a)(i).
§ 1910.308(d)(3)(i)	§ 1910.399(a)(77).
§ 1910.308(d)(3)(ii)	§ 1910.399(a)(75).
§ 1910.308(d)(3)(iii)	§ 1910.399(a)(2).
§ 1910.308(d)(3)(iv)	§ 1910.399(a)(22).
§ 1910.308(d)(3)(v)	§ 1910.399(a)(127).
§ 1910.309(a)	§ 1910.302(b)(1).
§ 1910.309(b)	§ 1910.302(b)(2).
§ 1910.309(c)	§ 1910.304(b)(l).

The following discussion summarizes the final standard and the effects this rulemaking has on the former provisions of §§ 1910.308 and 1910.309. Any changes made from the proposal are noted; otherwise, the requirements in the proposal have been adopted with no substantive change.

§ *1910.301 Introduction.* The former introductory paragraphs, § 1910.308 (a) and (b), which incorporated the 1971 NEC into Subpart S by reference, have been deleted. A new introductory § 1910.301 addresses the new format followed in this Subpart. The basic areas which are or will be included in Subpart S of Part 1910 are set forth as follows:

(a) Design Safety Standards for Electrical Systems. The standards which are the subject to this rulemaking are contained in §§ 1910.302 through 1910.330. (At this time, however, only §§ 1910.302 through 1910.308 are being promulgated; §§ 1910.309 through 1910.330 have been reserved for possible future design safety standards for other electrical systems, such as power generating systems.)

(b) Safety-Related Work Practices. These regulations will be contained in §§ 1910.331 through 1910.360.

(c) Safety-Related Maintenance Requirements. These requirements will be contained in §§ 1910.361 through 1910.380.

(d) Safety Requirements for Special Equipment. These requirements will be contained in §§ 1910.381 through 1910.398.

(e) Definitions applicable to each of these four major divisions are contained in a common § 1910.399.

Since the areas covered by each of these four major divisions represent broadly diverse equipment, installations and practices, it is intended that each division will be further subdivided where appropriate. For example, within the category involving design safety standards for electrical systems, separate subgroupings could include electrical utilization systems, electrical power generation and transformation systems, electrical power transmission and distribution systems, and others, in the future.

The changes to Subpart S contained in the present document are limited to electrical utilization systems, as covered by the former OSHA electrical standards.

This standard places the relevant requirements of the National Electrical Code into the text of the regulations making it unnecessary to incorporate the National Electrical Code by reference. The former incorporation of the entire NEC is therefore being deleted.

§ *1910.302 Electric Utilization Systems (Scope and Extent of Application).*

§ *1910.302(a).* The provisions formerly in the scope paragraph, § 1910.308(c), have been carried forward in new scope paragraph § 1910.302(a). Additionally, as proposed, § 1910.302(a)(vi) in the final rule includes "industrial substations", which was inadvertently omitted in the adoption of the former OSHA standard.

§ *1910.302(b)(1).* The National Electrical Code requirements formerly listed in paragraph § 1910.309(a), which were applicable to all electrical installations and utilization equipment, have been retained in part and deleted in part. The retained part no longer references sections of the NEC, but instead references the corresponding provisions of Subpart S. These requirements are carried forward as § 1910.302(b)(1). The deleted portion consists of the sections of the 1971 NEC which are inappropriate for OSHA's use or otherwise covered in this subpart. The specific sections deleted, along with the reasons for the deletions, and the new paragraph numbers of the retained NEC sections are given in the following distribution table:

Distribution Table

1971 NEC provision referenced in former § 1910.309(a)	New section of subpart S
Articles:	
500	These Articles were rewritten in performance terms and combined into § 1910.307.
501	
502	
503	
Sections:	
110–14(a)	Deleted—Covered by § 1910.303(a).
110–14(b)	§ 1910.303(c).
110–17(a), (b), and (c).	§ 1910.303(g)(2).
110–18	§ 1910.303(d).
110–21	§ 1910.303(e).
110–22	§ 1910.303(f).
240–16	§ 1910.304(e)(1)(iv).
240–19(a) and (b).	§ 1910.304(e)(1)(v).
250–3(a)	§ 1910.304(f)(1)(ii)
250–3(b)	Deleted—Inappropriate; this section is not a requirement but only states that certain systems over 300 volts may be grounded.
250–5 (a), (b), and (c).	§ 1910.304(f)(1) (iii), (iv), and (v).
250–7	Deleted—covered in § 1910.307.
250–42 (a), (b), (c), and (d).	§ 1910.364(f)(5)(iv) (*a*), (*b*), (*c*), and (*d*).
250–43 (a), (b), (c), (d), (e), (f), (g), (h) and (i).	Deleted—covered in § 1910.304(f)(5)(iv).
250–44 (a), (b), (c), and (d).	§ 1910.304(f)(5)(vi).
250–44(e)	Deleted—covered by § 1910.304(f)(5)(iv).
250–45 (a), (b), and (d).	§ 1910.304(f)(5)(v).
250–45(c)	Deleted—inappropriate; applies only to residences.
250–50 (a) and (b).	§ 1910.304(f)(3).
250–51	§ 1910.304(f)(4).
250–57(a) and (b).	§ 1910.304(f)(6)(i).
250–58 (a) and (b).	Deleted—inappropriate; these are not requirements but optional methods of meeting the grounding requirement.
250–59 (a), (b) and (c).	Deleted—inappropriate; these sections are not requirements but only suggest methods of grounding.
400–3 (a) and (b).	§ 1910.305(g)(1) (i) and (ii).
400–4	§ 1910.305(g)(1)(iii).
400–5	§ 1910.305(g)(2)(ii).
400–9	§ 1910.304(e)(1)(i).
400–10	§ 1910.305(g)(2)(iii).
422–8	Deleted—covered by § 1910.305(g)(1)(i).
422–9	Deleted—covered by § 1910.303(g)(2).
422–10	Deleted—covered by § 1910.303(b).

Distribution Table—Continued

1971 NEC provision referenced in former § 1910.309(a)	New section of subpart S
422-11	Deleted—inappropriate; this section addresses appliance construction detail requirements.
422-12	Deleted—inappropriate; this section addresses appliance construction detail requirements.
422-14	Deleted—inappropriate; this section addresses appliance construction detail requirements.
422-15 (a), (b) and (c).	Deleted—covered by § 1910.303(a).
422-16	Deleted—covered by § 1910.304(f) and the standard procedure for a variance request.
422-17(a)	Deleted—inappropriate; this is not a requirement, but a definition of a term no longer used in the standard.
422-17(b)	Deleted—covered by § 1910.303(a).
430-142	Deleted—covered by § 1910.304(f)(5)(iv).
430-143	Deleted—covered by § 1910.304(f)(5)(v).

The provisions which are listed in § 1910.302(b)(1) apply to all electrical installations and utilization equipment regardless of when they were designed or installed. For discussion of comments on and objections to the application of these provisions, see Issue 3 in Section III of this preamble.

§ 1910.302(b)(2). Proposed § 1910.302(b)(2), as well as former § 1910.309(b), applied the full coverage of Subpart S to "every replacement, modification, repair, or rehabilitation made to an existing installation after March 15, 1972." At the November 8, 1979, public meeting (Meeting Tr. 9–10) and at the public hearing (Tr. 26), OSHA officials interpreted this provision as being limited to "major" replacements, modifications, repairs, or rehabilitations. Other witnesses supported this interpretation but requested that the word "major" be added to § 1910.302(b)(2), to ensure consistent application by compliance personnel (Tr. 170, 269–270, 294).

Concerned that such wording could be ambiguous, OSHA requested the hearing witnesses to supply definitions or clarifications of what would be "major replacement, modifications, repairs, or rehabiliations." The respondents contended that "major" should refer to work which is similar to that involved when a new building or facility is built, a new wing is added, or an entire floor is renovated (Ex. 19, 55K, 62).

There is no objection to the addition of the word "major" to § 1910.302(b)(2) and OSHA agrees that it more accurately reflects the intent of this paragraph. Therefore, § 1910.302(b)(2) has been modified to indicate that "every major replacement, modification, repair, or rehabilitation, after March 15, 1972," must comply with all the requirements of § 1910.302 through 1910.308. Also, a note has been added to indicate that such "major" work includes work of a magnitude similar to that involved when a new building is built, a new wing is added to an existing facility, or an entire floor is renovated.

§ 1910.302(b)(3). A new § 1910.302(b)(3) has been added which contains a list of paragraphs that impose new requirements which were not in the 1971 NEC. Since the requirements in these paragraphs were not in the former standards, they will only apply to installations made after the effective date of these standards. The paragraphs involved are the following:

§§ 1910.303(h)(4)(i) and (ii)—Entrance and access to workspace (over 600 volts).
§ 1910.304(e)(i)(vi)(*b*)—Circuit breakers operated vertically.
§ 1910.304(e)(l)(vi)(*c*)—Circuit breakers used as switches.
§ 1910.304(f)(7)(ii)—Grounding of systems of 1000 volts or more supplying portable or mobile equipment.
§ 1910.305(j)(6)(ii)(*b*)—Switching series capacitors over 600 volts.
§ 1910.306(c)(2)—Warning signs for elevators and escalators.
§ 1910.306(i)—Electrically controlled irrigation machines.
§ 1910.306(j)(5)—Ground-fault circuit interrupters for fountains.
§ 1910.308(a)(1)(ii)—Physical protection of conductors over 600 volts.
§ 1910.308(c)(2)—Marking of Class 2 and Class 3 power supplies.
§ 1910.308(d)—Fire protective signaling circuits.

The effective date for these provisions is discussed and explained in Section VI of this preamble.

General

As was the case with the former provisions of Subpart S, the revised Subpart does not apply to construction and agriculture. It does apply to all other workplaces covered by OSHA, except that for maritime, § 1910.302(a)(2)(i) provides that ships and other watercraft are not covered. Some commenters pointed out that the proposed standard inadvertently contained requirements pertaining to construction, even though (as noted in the preamble to the proposal) 29 CFR Part 1910, Subpart S does not apply to this industry (Ex. 30). Therefore, the final standard reflects the deletion of the following proposed provisions or references which deal exclusively with construction.

§ 1910.305(a)(2)(i)(*a*)—Use of temporary wiring for construction.
§ 1910.305(a)(2)(iii)(*g*)—Splices on construction sites.

§ 1910.303 General Requirements. This section contains general requirements for electrical installations. These requirements address approval and use of equipment, splices, marking and identification, working clearances, and guarding of live parts. Approval and marking requirements were the only regulations in this section which were major issues. For detailed discussion on these topics, see Issue 4 in Section III of this preamble. Specific paragraphs and substantive changes from the proposal are discussed as follows:

Paragraph (a) requires approval of electrical equipment, while paragraph (b) gives provisions for the equipment's inspection and use. These two paragraphs basically require employers to provide equipment which is in safe condition and to ensure that it is used safely.

Paragraph (c) requires splices to be suitably made and insulated. Parts of electric equipment that produce arcs, sparks, or molten metal are required to be appropriately guarded by § 1910.303(d).

Marking and identification are covered in § 1910.303(e) and (f). In paragraph (e), electric equipment is required to be marked to identify who made the equipment and what the necessary electrical ratings are. Paragraph (f) requires branch circuits, feeders, services, and disconnecting means for equipment to be identified. In the proposal, this requirement read as follows:

(f) *Identification of disconnecting means.* Each disconnecting means required by this subpart for motors and appliances shall be legibly marked unless located and arranged so that its purpose is evident; and each disconnecting means required by this subpart for each service, feeder, or branch circuit shall be legibly marked to indicate its purpose at the point where the service, feeder or branch circuit originates. The marking shall be of sufficient durability to withstand the environment involved.

This wording is slightly different from the NEC and NFPA 70E. It was changed in an attempt to clarify the requirement without changing the intent. However, as evidenced by some of the comments received (Ex. 2), the modification created additional confusion regarding marking of service, feeder, and branch circuit disconnects. For example, the proposed subpart contained no requirements for these circuits to have disconnecting means, seemingly making the identification requirement for such disconnecting means superfluous. Therefore, OSHA is again revising the language to clarify the intent of the rule. This paragraph now clearly requires each service, feeder, or branch circuit to be identified, at its disconnecting means or overcurrent device, to indicate the circuit's purpose. However, no marking

is necessary if the purpose of the circuit is evident. This clarification, which is consistent with OSHA's former regulation, the NEC, and NFPA 70E, should clear up any misunderstanding created by the proposed requirement.

Paragraphs (g) and (h) set forth requirements pertaining to guarding of and working clearances around live parts of electric equipment. Regulations applying to equipment 600 volts or less can be found in § 1910.303(g), while paragraph (h) applies over 600 volts. One commenter (Ex. 12) pointed out that OSHA's proposal and NFPA 70–E contained an error in the exception to § 1910.303(h)(3)(i). In the second sentence, it was noted that "energized" should be "de-energized", as it is in 1978 NEC Section 110–34(a) from which the OSHA requirement was derived. The final rule contains this correction.

4. § *1910.304 Wiring Design and Protection.* This section covers the design requirements for wiring systems from the service conductors to the branch circuit conductors. It also covers requirements for the protection of electric conductors from both overcurrent and physical hazards.

Paragraph (a) requires that both the grounded circuit conductor and the equipment grounding conductor be identifiable and distinguishable from other conductors. These regulations have been written in more performance oriented terms than the former requirements which required that those conductors be identified in a specific manner.

A comment was received suggesting the inclusion of a provision which was contained in Section 410–55(c) of the 1971 NEC, but was not carried forward in the proposal on the presumption that it was covered by other proposed provisions. This provision prohibited the use of grounding terminals or grounding-type devices for purposes other than grounding. It was claimed that several fatalities in South Carolina were attributable to the placing of an ungrounded conductor on the grounding terminal of a receptacle, plug, or connector (Ex. 2). Similar accidents have been found in OSHA's records (Ex. 4).

Upon examining proposed provisions relating to grounding, OSHA has determined that the requirement of 1971 NEC Section 410–55(c) was not adequately covered elsewhere in the proposal. Therefore, since this provision is contained in OSHA's former regulations and since fatalities have occurred which are directly attributable to violations of this requirement, the following paragraph has been added to the final standard as new § 1910.304(a)(3):

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

Paragraph (b) includes the requirements for sizing of outlet devices and for ground-fault protection for personnel on construction sites.

Paragraph (c) contains location and clearance requirements for low voltage (600 volts or less) conductors and lamps that are located outside. Paragraph (d) of this section requires that a disconnecting means be provided for the service entrance conductors. It also contains the location, marking and operational requirements for that disconnect.

Paragraph (e) contains overcurrent protection requirements for both low voltage and high voltage conductors.

Paragraph (e)(1)(vi) has been broken down into three separate paragraphs. The two provisions dealing with mounting and marking of circuit breakers have been renumbered as (e)(1)(vi)(*b*) and (*c*), and are effective only to equipment installed after the effective date of this standard, as noted in § 1910.303(b)(3).

The grounding requirements for electric systems are contained in paragraph (f) of this section. This paragraph is subdivided into seven categories as follows:

(1) Systems to be grounded.
(2) Conductors to be grounded.
(3) Grounding connections.
(4) Grounding path.
(5) Supports, enclosures, and equipment to be grounded.
(6) Methods of grounding fixed equipment.
(7) Grounding of systems and circuits of 1,000 volts and over (high voltage).

There were two major issues raised on the regulations contained in paragraph (f). One involved new § 1910.304(f)(4) *Grounding path.* This requirement, which is unchanged from the proposal, is discussed in issue number 5 of Section III of this preamble. The other major issue concerned new § 1910.304(f)(6) *Methods of grounding fixed equipment.* Paragraph (f)(6)(i) has been modified to prohibit the use of building steel as the equipment grounding conductor for installations made after the effective date of these standards. This subject is discussed in Issue 6 of Section III of this preamble.

All of the remaining requirements contained in paragraph (f) were contained in the former regulation, and any changes to those requirements are strictly editorial. For example, the word "devices" has been changed to "appliances" in § 1910.304(f)(5)(iv)(*f*)(*2*) because the equipment does not meet the definition of a "device", as set forth in § 1910.399(a)(38), meaning "a unit of an electrical system which is intended to carry but not utilize electric energy." Similarly, the word "portable" as used in § 1910.304(f)(7)(ii) has been changed to "portable or mobile", the equipment referred to in the applicable paragraphs is mobile but not necessarily easily carried. A similar change has also been made in the 1981 NEC.

§ *1910.305 Wiring Methods, Components, and Equipment for General Use.* This section contains installation requirements for equipment (in general), wiring components, and wiring methods. None of the requirements of this section were major issues during the rulemaking proceeding, except as to whether they should be more or less performance-oriented. (The performance vs. specification question is discussed in Issue 1 of Section III of this preamble.)

In response to comments received, OSHA has revised some provisions, and these revisions are discussed along with the requirements of this section:

Paragraph (a) deals with wiring methods. General wiring requirements (electrical continuity and wiring in ducts) are the subject of § 1910.305(a)(1). In this paragraph, continuity of metal raceways and enclosures is required and wiring in certain ducts is prohibited.

Paragraph (a)(2) gives requirements on temporary wiring, including its permitted uses. In general, temporary wiring is permitted to be of a class less than permanent wiring, but must follow most of the rules of permanent installations, except as noted in that paragraph. For the reasons discussed earlier under § 1910.302, the references to construction in §§ 1910.305 (a)(2)(i)(*a*) and (a)(2)(ii) have been deleted. Similarly, the first sentence of proposed § 1910.305(a)(2)(iii)(*g*), which related solely to construction, has been deleted.

Paragraphs (a)(3) and (a)(4) address two wiring methods, namely, cable trays and open wiring. These provisions give general installation and use requirements. In the final rule, proposed § 1910.305(a)(3)(i)(*b*)(*3*) has been renumbered § 1910.305(a)(3)(i)(*c*).

Paragraph (b) requires cabinets, boxes, and fittings to provide a complete enclosure for conductors and to have only smooth surfaces in contact with conductors.

Paragraphs (c) and (d) relate to switches, switchboards, and panelboards, and require protection from live parts.

Weatherproof enclosures are required for wet locations in paragraph (e).

Paragraph (f) requires conductors to have suitable insulation.

Paragraphs (g) and (h) cover the use of flexible cords and portable cables. Uses which are permitted and not permitted are listed in paragraph (g)(1), while paragraph (g)(2) details requirements for identification, splices, and termination of flexible cords. Requirements applicable to portable cables for use over 600 volts are contained in paragraph (h).

Fixture wires are addressed in § 1910.305(i). This paragraph gives permitted uses for fixture wires and does not allow their use for general branch circuit wiring.

Paragraph (j) contains requirements for wiring of equipment for general use. Paragraphs (j)(1) and (2) cover lighting equipment, plugs, and receptacles. Marking, guarding, and disconnection requirements for appliances are given in § 1910.305(j)(3).

Requirements for motors are contained in paragraph (j)(4). Motors are required to have suitable cover current protection and disconnection means. Guarding requirements are also provided in that paragraph.

Paragraph (j)(5) gives safeguarding requirements for transformer installations. Depending on their rating, some transformers must be in a vault. Stated in performance language, § 1910.305(j)(5)(vi) requires such vaults to be able to contain fires and combustible liquids. Although no specific fire rating is given, any vault constructed in accordance with NEC specifications in Article 450 would be acceptable.

Capacitor switching and charge drainage are addressed in § 1910.305(j)(6). Paragraph 1910.305(j)(6)(ii)(*b*), which gives switching specifications for series capacitors over 600 volts, was proposed as a new requirement and will apply only to installations made after the effective date of these standards.

Paragraph (j)(7) requires storage battery installations to have adequate ventilation.

6. § *1910.306 Specific Purpose Equipment and Installations.* This section contains regulations for equipment which is not adequately covered by the general requirement elsewhere in Subpart S.

Paragraph (a) covers electric signs and outline lighting. It includes specific requirements for disconnecting means and a requirement that access doors be interlocked to deenergize any live parts operating at over 600 volts when the sign or outline lighting is accessible to other than qualified persons. Paragraph (b) covers cranes and hoists and includes specific requirements for disconnects, control switches, and required working clearance.

Paragraph (c) includes specific requirements for disconnects and location of control panels associated with elevators, dumbwaiters, escalators, and moving walks.

A new provision requiring that a warning sign be mounted on or adjacent to the disconnecting means under certain conditions was included in § 1910.306(c)(1) of the proposal. This requirement has been renumbered in the final standard as § 1910.306(c)(2) and applies only to installations made after the effective date of these standards.

Specific requirements relating to disconnecting means, controls, guarding, grounding and labeling for electric welders, X-ray equipment for nonmedical and nondental use, and induction and dielectric heating equipment are included in paragraphs (d), (f), and (g).

Paragraph (e) contains disconnect requirements for data processing systems and was divided in the proposal into requirements for data processing rooms and requirements for general building areas. OHSA received comments (Ex. 2) stating that clarification should be made to indicate that disconnection of all equipment, such as typewriters and lights is not addressed by this paragraph. In addition, these same commenters questioned the extent of application to general building areas and requested clarification regarding when additional disconnects were required in those areas. The comments in the record are further supported by the decision of the NFPA 1981 NEC Code Committee to limit this requirement to electronic equipment, and only when installed in a computer room or data processing room. The change was made to avoid requiring associated equipment such as typewriters and even fire warning and fire supression systems to be disconnected with the data processing systems. These machines have nothing to do with protecting employees from hazards associated with data processing systems. Paragraph (e) in the final standard has therefore been modified to reflect these changes.

Paragraph (h) includes specific regulations on electrolytic cells. These requirements were not contained in the former standard but were proposed because of the unique operational requirements of these cells. These provisions, which are discussed in issue number 8 of Section III, have been adopted in the final rule as proposed.

Paragraph (i) contains specific requirements, which were not in the former standard, relating to electrically driven or controlled irrigation machines. This paragraph is applicable only to installations made after the effective date of these standards.

Paragraph (j) contains regulations for swimming pools, fountains, and similar installations other than therapeutic pools in health care facilities. Specific provisions include location requirements for lighting and receptacles and methods for determining which circuits require ground-fault circuit interrupters. Paragraph (j)(2)(c) in the proposal has been renumbered (j)(3) to make it clear that this requirement applies to all cord- and plug-connected equipment and not just to lighting fixtures and lighting outlets. Proposed paragraphs (j)(3) and (j)(4) have also been renumbered as (j)(4) and (j)(5) respectively and a note has been added to new § 1910.306(j)(5) indicating that it is applicable only to installations made after the effective date of these standards.

7. § *1910.307 Hazardous Locations.* Paragraph (a) gives the scope of this section and lists typical hazardous locations.

The remainder of this section was completely rearranged from the proposal to indicate its intent more clearly. The basic requirements for hazardous locations were contained in proposed § 1910.307(c), which read as follows:

> (c) *Electrical installations.* Equipment wiring methods, and installations of equipment in classified locations shall be one or more of the following:
>
> (1) Intrinsically safe.
>
> (2) Approved for the classified location.
>
> (3) Of a type and design which provides protection from the hazards arising from the combustibility and flammability of vapors, liquids, gases, dusts, or fibers.

The proposal was confusing to many interested persons in that other requirements or guidelines, which explained the three alternatives of § 1910.307(c), were scattered throughout § 1910.307. Confusion about these provisions appears to have been the cause of many of the misunderstandings discussed in relation to Issues 3 and 4 of Section III of this preamble.

In order to avoid the confusion and clarify the wording, OHSA has reorganized the final standard to combine the basic requirements with their respective related provisions. For example, provisions related to "approved" equipment have been combined under the option which allows the use of equipment which is "approved for the classified location." OHSA believes that this reorganization of § 1910.307 will make the section easier to understand.

Guidelines for determining what equipment and installations are "safe for the hazardous location" and thus meet § 1910.307(b)(3)) of the final standard (proposed § 1910.307(c)(3)) are contained in Chapter 5 of the current National Electrical Code (NFPA 70). However, these guidelines are not the only means of complying with the standard. Any equipment or installation which is shown by the employer to provide protection from the hazards involved will be acceptable. This performance-oriented approach will allow the employer maximum flexibility in providing safety for his employees.

8. § *1910.308 Special Systems.* Paragraph (a) of this section addresses electrical systems over 600 volts, nominal. Requirements are given for wiring methods, interrupting and isolating means, mobile and portable equipment, and tunnel installations. The provision in proposed paragraph (a)(1) requiring conductors emerging from the ground to be enclosed is a new requirement not in OHSA's previous standards. Therefore, in the final standard, this provision has been renumbered as paragraph (a)(1)(ii) and applies only to installations made after the effective date of these standards.

Paragraph (b) covers emergency power systems. Wiring for these systems is required to be separate from the normal supply wiring. Additionally, where emergency lighting is required, no space may be left in total darkness as a result of the failure of a single emergency lighting element.

Requirements for remote control, signaling, and power-limited circuits are contained in paragraph (c). Depending on the voltage, current, and power limitation, these circuits have been designated as Class 1, Class 2, or Class 3. Paragraph (c)(2) requires Class 2 and Class 3 systems to be marked; however, this requirement applies only to systems installed after the effective date of these standards, since this is a new requirement.

Fire protective signaling systems are covered in paragraph (d), which addresses classification, separation, and identification of these systems. Since this entire paragraph was not contained in OSHA's former standards, it applies only to installations made after the effective date of these standards.

Paragraph (e) applies to communications systems and contains provisions on protective devices, conductor and equipment locations, and grounding. Some commenters indicated that the proposal conflicted with both the 1971 and 1978 NEC by not making § 1910.308(e) the only provision in Subpart S covering communications systems (Ex. 45, 48). They suggested that OSHA include a statement in the regulation stating that communications systems were covered only in § 1910.308(e).

The omission of such a statement from the proposal was an oversight on OSHA's part. To correct this, OSHA has added the following sentence in § 1910.308(e):

> These installations need not comply with the provisions of §§ 1910.303 through 1910.308(d).

9. § *1910.399 Definitions.* This section provides definitions for Subpart S. The definitions in the final rule remain as proposed, except as follows:

(a)(24) "Class I locations": The definition of a Class I, Division 1 location has been changed by deleting the words "continuously, intermittently, or periodically." The rationale for this change is discussed in Issue 7 of Section III of this preamble. The note following this section has also been changed to more clearly describe this type of location.

(a)(25) "Class II locations": The definition of a Class II, Division 1 location has been changed by deleting the words "continuously, intermittently, or periodically." The definition of a Class II, Division 2 location (§ 1910.399(a)(25)(ii)) has also been changed to clarify the difference between Division 1 and Division 2 locations. Additionally, the fine print notes following these definitions have been modified to more accurately reflect examples of *locations* which could be classified as Class II locations considering advances in grain handling technology. The rationale for these changes is discussed in Issue 7 of Section III of this preamble.

(a)(128) "Utilization system": One commenter (Ex. 30) questioned this definition, stating that it was redundant with the definition of "premises wiring." However, the terms are not synonymous, and the final rule has been modified to clearly state that the utilization system includes not only the premises wiring system, but its associated utilization equipment as well.

V. Regulatory Assessment

In accordance with Executive Order No. 12044 (43 FR 12661, March 24, 1978), OSHA assessed the potential economic impact of the proposal. Based on the economic identification criteria developed by the Department of Labor (44 FR 5570, January 28, 1979), OSHA concluded that the subject matter of the proposal was not a "major" action which would necessitate further economic impact evaluation and the preparation of a Regulatory Analysis.

The proposal dealt with electrical installation safety requirements and was derived from the National Electrical Code, which was used as OSHA's previous standard. Since the proposal resulted in an overall simplification of OSHA's standards, the estimated cost of compliance was concluded not to be higher than the cost of compliance with the current OSHA standards.

This determination was based on a May 11, 1979, report by JRB Associates, Inc. The major finding of the economic impact assessment was that there would be no significant economic effect resulting from the promulgation of the proposed revisions to 29 CFR Part 1910, Subpart S, Electrical. The rationale for this conclusion was as follows:

—The proposed regulation contained no requirements other than those found in either 29 CFR Part 1910, Subpart S, or the 1978 National Electrical Code.

—Current industry practice for new installation is to conform to the 1978 National Electrical Code.

—Provisions in the proposed Subpart S had an antecedent in the 1978 National Electrical Code.

Several commenters took issue with OSHA's determination that the proposed revisions to Subpart S would not have a major economic impact on the affected industries. Detailed studies were submitted to the record by certain industry groups, notably the grain elevator industry and the feed manufacturing industry, which indicated that the costs of compliance with Subpart S as revised would be far greater than those associated with compliance with the current provisions. (Ex. 55J, 58). However, a review of these studies reveals that their findings are based on certain misunderstandings of the scope and application of the former standards and OSHA's proposed revisions. These areas of concern are also discussed in detail in section III of this preamble, which deal with the "retroactive" and hazardous locations provisions of the standard. Nonetheless, OSHA believes that it may also be helpful to discuss these major areas of misunderstanding in the context of the regulatory assessment of the proposed standards.

OSHA's intent in proposing changes to Subpart S was to simplify compliance with the electrical standards, without reducing any of the employee protection currently provided. To that end, the proposed revisions to Subpart S approached the problem in three ways: first, performance language was substituted for the detailed requirements of the 1971 NEC, to provide flexibility for the employer; second, provisions of the 1971 NEC which were directed

primarily at property protection and not at employee protection were deleted; and third, all relevant provisions from the NEC were placed within Subpart S in place of the incorporation by reference of the NEC itself. The net result of the proposed revisions, therefore, was a significant decrease in the regulatory burden imposed by the electrical standards. In the limited circumstances in which the proposed standards imposed obligations not contained in the 1971 NEC as applied in the present standards, OSHA intended that these new obligations only apply to installations made after the effective date of the revised standards. (As noted in section VI of this preamble, OSHA acknowledged that this intention was not implemented totally in the proposal; such new provisions are more carefully and completely distinguished in the final standards.)

Concerning the question of the listed "retroactive" provisions in proposed § 1910.302(b)(1), it should be noted that the proposed revisions did no more than carry forward the provisions of current § 1910.309(a), which presently apply to all electrical installations, regardless of when they were made. Indeed, where the list has been modified, the changes simplify and reduce the compliance burden by eliminating requirements and allowing alternative compliance methods. There is no requirement imposed by the new § 1910.302(b)(1) that is not currently imposed on employers by virtue of § 1910.309(a) of the former standards. Thus, the costs of complying with these requirements cannot be attributed to the proposal.

OSHA based its economic impact analysis on the requirements of Executive Order No. 12044 (43 FR 12661, March 24, 1978), as supplemented by Department of Labor regulations (44 FR 5570, January 26, 1979). The regulatory assessment of the proposed regulations was intended to evaluate the incremental cost impact of the proposal over that of the existing regulations.

Since OSHA's proposal did not increase existing compliance requirements or establish new compliance requirements, it was found not to result in a major impact.

To support their view that OSHA's assessment was inadequate, two trade assocations submitted studies of the economic impact on their respective industries, based upon their interpretations of the proposal. One study claimed that it would cost the feed manufacturing industry about $785,000,000 to comply with OSHA's proposal, the other estimated costs of $825,000,000 for the grain elevator industry (Ex. 55J, 58).

It is difficult to evaluate the industry studies in depth: although specific compliance elements are mentioned in each study, the actual cost data are not adequately broken down to correspond to those elements. Therefore, there is no way to determine how much of their total cost estimates are attributable to which compliance activity. This is particularly troublesome for two reasons: first, when the costs are calculated based on an inaccurate reading of the standards, the magnitude of these unnecessary costs cannot be determined. It is noted, however, that in their other comments and testimony submitted to the record, these parties' primary concerns with the proposal centered on the costs of removal and replacement of unmarked, unlabeled and unapproved equipment in hazardous (classified) locations. As noted earlier, such requirements, and, therefore, their costs, are illusory. Clearly, then, if these costs constitute the greatest share of the total estimated compliance costs in these studies, the studies greatly overestimate the resources necessary for compliance with the standards.

Second, where repair costs are included as costs of compliance, such costs are also not properly attributable to the proposal. The proposal did not add any new requirements for existing installations; thus, where repairs are required for compliance with the proposal, they would also be necessary for compliance with the current standards. In addition, some repair costs may well be directed more towards routine operating repairs for continuing or resuming production in currently idle facilities than they are towards compliance with OSHA standards.

The inaccurate assumptions which appear to be the basis of much of the cost data in the industry studies have been discussed in depth in earlier sections of this preamble. The following discussion, therefore, represents a summation of the relevant issues as they pertain to the regulatory assessment.

Both industry studies assumed that all installations in hazardous locations were required to have "approved" equipment. (See issue 4(b) in section III of this preamble).

The studies also confused the terms "marking", "labeling", and "approval" and assumed that OSHA's standard differed from the NEC as to those terms (See Issue 4(a) in section III of this preamble). Contrary to the implications in the studies, the marking provisions in the standard do not require labeling or approval; they simply require identification of the various parameters of the equipment. This identification may be placed on the equipment using any means that is legible and durable enough to withstand the operating environment. As such, many of the costs indicated by the studies would not be incurred as employers would not be required to affix official manufacturers' labels or replace equipment which does not have such labels. Furthermore, the studies included in their estimates the cost of replacing otherwise acceptable equipment which is not listed or labeled, and hence not "approved." Such replacement of unapproved but otherwise acceptable equipment is not required by the standard if the equipment can be shown to meet one of the other compliance alternatives in § 1910.307.

Should some items of equipment not meet any of the compliance alternatives in § 1910.307, replacement of that equipment would be necessary. Assuming that an item of equipment would need to be replaced, the study did not take into account any possible salvage value of the used equipment. In addition, the studies did not consider the savings that might result from reduction in insurance premiums, property losses, and liability costs as a result of replacing unsafe equipment with safe equipment.

Where costs are imposed by the existing standards, the proposal does not increase these costs; to the contrary, as the assessment points out, the net impact of the proposal is expected to be an overall reduction in compliance costs due to the use of performance language and other reductions in the regulatory burdens imposed by the former standard.

One commenter contended that OSHA should have conducted a field survey to ascertain the present level of compliance with the current "retroactive" provisions in § 1910.309(a). Based on that survey, it was argued, OSHA should then have assessed not only the costs of compliance with new requirements imposed by the proposal, but the added costs of coming into compliance with the existing standards. (Ex. 69).

Because the proposed "retroactive" provision of § 1910.302(b)(1) did not increase compliance requirements over those of § 1910.309(a) (see Issue 3 in section III of this preamble). OSHA determined that the impact of the proposal in this regard was not major. Where industry is not currently in compliance with the existing standards, these costs cannot be attributed to the proposal. The regulatory assessment therefore, properly evaluated the incremental costs to be imposed by the proposed standard.

The regulatory assessment concluded that the only area in which increased costs might be expected is that of new provisions which were taken from the 1978 NEC and which were not in the 1971 NEC. Such costs were determined to be insignificant, particularly if the new provisions were to be applied only to installations made after the effective date of the final standards. This condition has been met by OSHA in the final revisions of Subpart S.

Therefore, after a careful review of the rulemaking record, OSHA has determined that this final standard is not a major action as defined in Executive Order 12044 and the Department economic criteria.

VI. Effective Date and Dates of Application

The scope and application of Subpart S, as set forth in paragraphs (b)(1) and (b)(2) of § 1910.302, essentially carry forward the provisions of § 1910.309 of the former standards. (The background and issues surrounding this section have been discussed at length in both Section III and Section IV of this preamble.) As in the case of previous § 1910.309(a), the provisions of Subpart S which are listed in new § 1910.302(b)(1) apply to all electrical installations, regardless of when they were made. Former § 1910.309(b) provided that the entire 1971 NEC applied to installations and modifications made after March 15, 1972. To be consistent with the former standard, the revision, in § 1910.302(b)(2), provides that the entire Subpart S applies to the same installations and modifications.

However, some of the provisions contained in the proposed regulations differed from or were not found in the previous regulations. These differences resulted from the use of the 1978 National Electrical Code as a base document. Since the previous regulations referenced the 1971 NEC, changes which were made in the subsequent editions of the NEC and which were included in the proposal appeared to impose new requirements.

OSHA had intended that all provisions in the proposal which were more stringent than the OSHA electrical standards in effect at the time would not apply to existing installations. Existing installations would not have to be retrofitted to meet these new requirements.

OSHA has added a new § 1910.302(b)(3) to indicate that the following new provisions apply only to installations made after April 16, 1981, the effective date of these standards.

(1) §§ 1910.303(h)(4)(i) and (ii). These requirements relate to access and entrance to workspace about equipment rated over 600 volts.

(2) § 1910.304(e)(1)(vi)(*b*). This requires the handle of vertically mounted circuit breakers to be in the up position when the breaker is on.

(3) § 1910.304(e)(1)(vi)(*c*). This provision would require circuit breakers used as switches in fluorescent lighting circuits to be marked "SWD."

(4) § 1910.305(j)(6)(ii)(*b*). This regulation addresses proper switching of series capacitors over 600 volts.

(5) § 1910.306(c)(2). This provision requires a warning sign for multicar elevator or escalator installations, under certain conditions.

(6) § 1910.306(i). This paragraph contains requirements for lighting protection and disconnection of electrically controlled or driven irrigation machines.

(7) § 1910.306(j)(4). This provision requires ground-fault circuit interrupters for fountain installations.

(8) § 1910.308(a)(1)(ii). This provision requires conductors over 600 volts emerging from the ground to be enclosed in a raceway.

(9) § 1910.308(c)(2) requires marking on Class 2 and Class 3 power supply units.

(10) § 1910.308(d). This paragraph contains requirements for fire protective signaling circuits.

In summary, § 1910.302(b) provides for three sets of provisions within Subpart S: paragraph (b)(1) contains the list of provisions applicable to all electrical installations; paragraph (b)(3) provides that the new requirements listed in that paragraph are only applicable to installations made after the effective date of these standards; and paragraph (b)(2) provides for the remainder of Subpart S to apply to new installations and major modifications made after March 15, 1972.

The effective date of these standards is (90 days after publication). The 90-day period between the issuance of the standards and their effective date is intended to provide sufficient time for employers and employees to become informed of the existence of the standards and their requirements.

The standards currently found in the existing Subpart S [§§ 1910.308–1910.309] will remain in effect until the standards contained in this document 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 Act, the current 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 March 2, 1981. Any petitions filed after this date will be considered to be filed untimely. This requirement is considered essential to permit the Agency to give full consideration to each petition and respond in advance of the effective date of the standards.

VII. Appendices

For informational purposes, one Appendix has been provided and two others reserved in this final standard. At this time only Appendix A is being promulgated. It contains a list of references which can provide guidance for employers who wish to know specifically what constitutes compliance with the performance standards. If an employer complies with the specific guidelines (the National Electrical Code, NFPA 70, in particular), that employer will be considered to be in compliance with the performance requirements given in OSHA's standard. At the same time, an employer may be in compliance with the standard although not complying with the specific requirements of the guidelines. In construing the meaning of the performance language in the standards in circumstances where the employer chooses not to comply with the specific provisions of the guidelines, OSHA will look at the specific guidelines among other things to determine whether the employer has complied with the standards' performance requirements. However, nothing contained in the appendices should be construed as establishing a mandatory requirement not otherwise imposed by the standard, or as detracting from an obligation which the standard does impose. In view of the nature of the appendices, changes in their contents may subsequently be made without rulemaking.

Three documents have been added to the list contained in the proposal. They are:

NMAB 353–1–79 Matrix of Combustion—Relevant Properties and Classifications of Gases, Vapors, and Selected Solids

NMAB 353–2–79 Test Equipment For Use in Determining Classifications of Combustible Dusts

NMAB–353–80 Classification of Combustible Dusts in Accordance with the National Electrical Code

VIII. Authority

This document was prepared under the direction of Eula Bingham, Assistant Secretary of Labor for Occupational Safety and Health, U.S. Department of

Labor, Third Street and Constitution Avenue, NW., Washington, D.C. 20210.

Accordingly, pursuant to sections 4(b)(2) and 6(b) of the Occupational Safety and Health Act of 1970 [84 Stat. 1592, 1593, 29 U.S.C. 653, 655], Secretary of Labor's Order No. 8–76 (41 FR 25059), and 29 CFR Part 1911, Subpart S of 29 CFR Part 1910 is revised as set forth below.

Signed at Washington, D.C. this 8th day of January, 1981.

Eula Bingham,

Assistant Secretary of Labor.

Part 1910 of Title 29 of the Code of Federal Regulations is hereby amended by revising Subpart S, Electrical, to read as follows:

* * * * *

Subpart S—Electrical

General

Sec.

Design Safety Standards for Electrical Systems

Safety-Related Work Practices

Safety-Related Maintenance Requirements

Safety Requirements for Special Equipment

Definitions

Authority: Secs. 4(b)(2) and 6(b), 84 Stat. 1592, 1593 (29 U.S.C. 653, 655), Secretary of Labor's Order No. 8–76 (41 FR 25059), 29 CFR Part 1911.

Subpart S—Electrical

General

§ 1910.301 Introduction.

This subpart addresses electrical safety requirements that are necessary for the practical safeguarding of employees in their workplaces and is divided into four major divisions as follows:

(a) *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.

(b) *Safety-related work practices.* These regulations will be contained in §§ 1910.331 through 1910.360.

(c) *Safety-related maintenance requirements.* These regulations will be contained in §§ 1910.361 through 1910.380.

(d) *Safety requirements for special equipment.* These regulations will be contained in §§ 1910.381 through 1910.398.

(e) *Definitions* applicable to each division are contained in § 1910.399.

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 of this subpart 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 of this subpart 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 communcation purposes.

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

(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) The requirements contained in the sections listed below shall apply to all electrical installations and utilization equipment, regardless of when they were designed or installed:

Sections:

1910.303(b)	Examination, installation, and use of equipment.
1910.303(c)	Splices.
1910.303(d)	Arcing parts.
1910.303(e)	Marking.
1910.303(f)	Identification of disconnecting means.
1910.303(g)(2)	Guarding of live parts.
1910.304(e)(1)(ii)	Protection of conductors and equipment.
1910.304(e)(1)(iv)	Location in or on premises.
1910.304(e)(1)(v)	Arcing or suddenly moving parts.
1910.304(f)(1)(iii)	2-Wire DC systems to be grounded.
1910.304(f)(1)(iii) and 1910.304(f)(1)(iv).	AC Systems to be grounded.
1910.304(f)(1)(v)	AC Systems 50 to 1000 volts not required to be grounded.
1910.304(f)(3)	Grounding connections.
1910.304(f)(4)	Grounding path.
1910.304(f)(5)(iv)(*a*) through 1910.304(f)(5)(iv)(*c*)	Fixed equipment required to be grounded.
1910.304(f)(5)(v)	Grounding of equipment connected by cord and plug.
1910.304(f)(5)(vi)	Grounding of nonelectrical equipment.
1910.304(f)(6)(i)	Methods of grounding fixed equipment.
1910.305(g)(1)(i) and 1910.305(g)(1)(ii).	Flexible cords and cables, uses.
1910.305(g)(1)(iii)	Flexible cords and cables prohibited.
1910.305(g)(2)(ii)	Flexible cords and cables, splices.
1910.305(g)(2)(iii)	Pull at joints and terminals of flexible cords and cables.
1910.307	Hazardous (classified) location.

(2) Every electric utilization system and all utilization equipment installed after March 15, 1972, and every major replacement, modification, repair, or rehabilitation, after March 15, 1972, of any part of any electric utilization system or utilization equipment installed before March 15, 1972, shall comply with the provisions of §§ 1910.302 through 1910.308.

Note.—"Major 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.

(3) The following provisions apply to electric utilization systems and utilization equipment installed after April 16, 1981:

§§ 1910.303(h)(4) (i) and (ii)	Entrance and access to workspace (over 600 volts).
§ 1910.304(e)(1)(vi)(*b*)	Circuit breakers operated vertically.
§ 1910.304(e)(1)(vi)(*c*)	Circuit breakers used as switches.
§ 1910.304(f)(7)(ii)	Grounding of systems of 1000 volts or more supplying portable or mobile equipment.
§ 1910.305(j)(6)(ii)(*b*)	Switching series capacitors over 600 volts.
§ 1910.306(c)(2)	Warning signs for elevators and escalators.
§ 1910.306(i)	Electrically controlled irrigation machines.
§ 1910.306(j)(5)	Ground-fault circuit interrupters for fountains.
§ 1910.308(a)(1)(ii)	Physical protection of conductors over 600 volts.
§ 1910.308(c)(2)	Marking of Class 2 and Class 3 power supplies.
§ 1910.308(d)	Fire protective signaling circuits.

§ 1910.303 General requirements.

(a) *Approval.* The conductors and equipment required or permitted by this subpart shall be acceptable only if approved.

(b) *Examination, installation, and use of equipment.* (1) *Examination.* Electrical 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. 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) Electrical insulation.

(iv) Heating effects under conditions of use.

(v) Arcing effects.

(vi) Classification by type, size, voltage, current capacity, specific use.

(vii) Other factors which contribute to the practical safeguarding of employees using or likely to come in contact with the equipment.

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

(c) *Splices.* Conductors shall be spliced or joined with splicing devices suitable for the use or by brazing, welding, or soldering with a fusible metal or alloy. Soldered splices shall first be so spliced or joined as 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 suitable for the purpose.

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

(e) *Marking.* Electrical equipment may not be used unless the manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the product may be identified is placed on the equipment. Other markings shall be provided giving voltage, current, wattage, and other ratings as necessary. The marking shall be of sufficient durability to withstand the environment involved.

(f) *Identification of disconnecting means and circuits.* 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. 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. These markings shall be of sufficient durability to withstand the environment involvement involved.

(g) *600 Volts, nominal, or less.* (1) *Working 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 clearances.* Except as required or permitted elsewhere in this subpart, the dimension of the working space in the direction of access to live parts operating at 600 volts or less and likely to require examination, adjustment, servicing, or maintenance while alive may not be less than indicated in Table S–1. In addition to the dimensions shown in Table S–1, workspace may not be less than 30 inches wide in front of the electric equipment. Distances shall be measured from the live parts if they are exposed, or from the enclosure front or opening if the live parts are enclosed. Concrete, brick, or tile walls are considered to be grounded. 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.

Table S–1.—*Working clearances*

Nominal voltage to ground	Minimum clear distance for condition[2] (ft)		
	(*a*)	(*b*)	(*c*)
0–150	[1] 3	[1] 3	3
151–600	[2] 3	3½	4

[1] Minimum clear distances may be 2 feet 6 inches for installations built prior to April 16, 1981.

[2] Conditions (*a*), (*b*), and (*c*), are as follows: (*a*) Exposed live parts on one side and no live or grounded parts on the othe 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. (*b*) Exposed live parts on one side and grounded parts on the other side. (*c*) Exposed live parts on both sides of the workspace [not guarded as provided in Condition (*a*)] with the operator between.

(ii) *Clear spaces.* Working space required by this subpart 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) *Access and entrance to working space.* At least one entrance of sufficient area shall be provided to give access to the working space about electric equipment.

(iv) *Front working space.* Where there are live parts normally exposed on the front of switchboards or motor control centers, the working space in front of such equipment may not be less than 3 feet.

(v) *Illumination.* Illumination shall be provided for all working spaces about service equipment, switchboards, panelboards, and motor control centers installed indoors.

(vi) *Headroom.* The minimum headroom of working spaces about service equipment, switchboards, panelboards, or motor control centers shall be 6 feet 3 inches.

Note.—As used in this section a motor control center is an assembly of one or more enclosed sections having a common power bus and principally containing motor control units.

(2) *Guarding of live parts.* (i) Except as required or permitted elsewhere in this subpart, live parts of electric equipment operating at 50 volts or more shall be guarded against accidental contact by 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 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 location on a suitable balcony, gallery, or platform so elevated and arranged as to exclude unqualified persons.

(d) By elevation of 8 feet or more above the floor or other working surface.

(ii) In locations where electric equipment would 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 paragraphs (a) through (g) of this section and with the following provisions which supplement or modify those requirements. The provisions of paragraphs (h)(2), (h)(3), and (h)(4) of this section do not apply to equipment on the supply side of the service conductors.

(2) *Enclosure for electrical installations.* Electrical installations in a vault, room, 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. A wall, screen, or fence less than 8 feet in height is not considered to prevent access unless it has other features that provide a degree of isolation equivalent to an 8 foot fence. The entrances to all buildings, rooms, or enclosures containing exposed live parts or exposed conductors operating at over 600 volts, nominal, shall be kept locked or shall be under the observation of a qualified person at all times.

(i) *Installations accessible to qualified persons only.* Electrical installations having exposed live parts shall be accessible to qualified persons only and shall comply with the applicable provisions of paragraph (h)(3) of this section.

(ii) *Installations accessible to unqualified persons.* Electrical installations that are open to unqualified persons shall be made with metal-enclosed equipment or shall be enclosed in a vault or in an area, access to which is controlled by a lock. If metal-enclosed equipment is installed so that the bottom of the enclosure is less than 8 feet above the floor, the door or cover shall be kept locked. Metal-enclosed switchgear, unit substations, transformers, pull boxes, connection boxes, and other similar associated equipment shall be marked with appropriate caution signs. If equipment is exposed to physical damage from vehicular traffic, suitable guards shall be provided to prevent such damage. Ventilating or similar openings in metal-enclosed equipment shall be designed so that foreign objects inserted through these openings will be deflected from energized parts.

(3) *Workspace 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 workspace may not be less than 6 feet 6 inches high (measured vertically from the floor or platform), or less than 3 feet wide (measured parallel to the equipment). The depth shall be as required in Table S–2. The workspace shall be adequate to permit at least a 90-degree opening of doors or hinged panels.

(i) *Working space.* The minimum clear working space in front of electric equipment such as switchboards, control panels, switches, circuit breakers, motor controllers, relays, and similar equipment may not be less than specified in Table S–2 unless otherwise specified in this subpart. Distances shall be measured from the live parts if they are exposed, or from the enclosure front or opening if the live parts are enclosed. However, working space is not required in back of equipment such as deadfront switchboards or control assemblies 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 de-energized parts on the back of enclosed equipment, a minimum working space of 30 inches horizontally shall be provided.

Table S–2.—*Minimum Depth of Clear working Space in Front of Electric Equipment*

Nominal voltage to ground	Conditions[2] (ft)		
	(a)	(b)	(c)
601 to 2,500	3	4	5
2,501 to 9,000	4	5	6
9,001 to 25,000	5	6	9
25,001 to 75kV[1]	6	8	10
Above 75kV[1]	8	10	12

[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 for 25,000 volts under Conditions (a), (b), and (c) for installations built prior to April 16, 1981.

[2] Conditions (a), (b), and (c) are as follows: (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 materials. Insulated wire or insulated busbars operating at not over 300 volts are not considered live parts. (b) Exposed live parts on one side and grounded parts on the other side. Concrete, brick, or tile walls will be considered as grounded surfaces. (c) Exposed live parts on both sides of the workspace not guarded as provided in Condition (a) with the operator between.

(ii) *Illumination.* Adequate illumination shall be provided for all working spaces about electric equipment. The lighting outlets shall be so arranged that persons changing lamps or making repairs on the lighting system will not be endangered by live parts or other equipment. The points of control shall be so located that persons are not likely to come in contact with any live part or moving part of the equipment while turning on the lights.

(iii) *Elevation of unguarded live parts.* Unguarded live parts above working space shall be maintained at elevations not less than specified in Table S–3.

Table S–3.—*Elevation of Unguarded Energized Parts Above Working Space*

Nominal voltage between phases	Minimum elevation
601 to 7,500	*8 feet 6 inches.
7,501 to 35,000	9 feet.
Over 35kV	9 feet + 0.37 inches per kV above 35kV.

*Note.—Minimum elevation may be 8 feet 0 inches for installations built prior to April 16, 1981 if the nominal voltage between phases is in the range of 601–6600 volts.

(4) *Entrance and access to workspace.* (See § 1910.302(b)(3).)

(i) At least one entrance not less than 24 inches wide and 6 feet 6 inches high shall be provided to give access to the working space about electric equipment. On switchboard and control panels exceeding 48 inches in width, there shall be one entrance at each end of such board where practicable. Where bare energized parts at any voltage or insulated energized parts above 600 volts 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.

§ 1910.304 Wiring design and protection.

(a) *Use and identification of grounded and grounding conductors.* (1) *Identification of conductors.* A conductor used as a grounded conductor shall be identifiable and distinguishable from all other conductors. 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) *Ground-fault protection for personnel on construction sites.* The employer shall use either ground-fault circuit interrupters as specified in paragraph (b)(1)(i) of this section or an assured equipment grounding conductor program as specified in paragraph (b)(1)(ii) of this section, to protect employees on construction sites. These requirements are in addition to any other requirements for equipment grounding conductors.

(i) *Ground-fault circuit interrupters.* All 120-volt, single-phase, 15- and 20-ampere receptacle outlets on construction sites, which are not a part of the permanent wiring of the building or structure and which are in use by employees, shall have approved ground-fault circuit interrupters for personnel protection. Receptacles on a two-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, need not be protected with ground-fault circuit interrupters.

(ii) *Assured equipment grounding conductor program.* The employer shall establish and implement an assured equipment grounding conductor program on construction sites covering all cord sets, receptacles which are not a part of the permanent wiring of the building or structure, and equipment connected by cord and plug, which are available for use or used by employees. This program shall comply with the following minimum requirements:

(*a*) 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 and any affected employee.

(*b*) The employer shall designate one or more competent persons (as defined in 29 CFR 1926.32(f)) to implement the program.

(*c*) 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 indication of possible internal damage. Equipment found damaged or defective may not be used until repaired.

(*d*) The following tests shall be performed on all cord sets, 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:

(*1*) All equipment grounding conductors shall be tested for continuity and shall be electrically continuous.

(*2*) 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.

(*e*) All required tests shall be performed:

(*1*) Before first use;

(*2*) Before equipment is returned to service following any repairs;

(*3*) 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

(*4*) 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.

(f) The employer may not make available or permit the use by employees of any equipment which has not met the requirements of this paragraph (b)(1)(ii) of this section.

(g) Tests performed as required in this paragraph 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.

(2) *Outlet devices.* Outlet devices shall have an ampere rating not less than the load to be served.

(c) *Outside conductors, 600 volts, nominal, or less.* Paragraphs (c)(1), (c)(2), (c)(3), and (c)(4) of this section apply to branch circuit, feeder, and service conductors rated 600 volts, nominal, or less and run outdoors as open conductors. Paragraph (c)(5) applies to lamps installed under such conductors.

(1) *Conductors on poles.* Conductors supported on poles shall provide a horizontal climbing space not less than the following:

(i) Power conductors below communication conductors—30 inches.

(ii) Power conductors alone or above communication conductors: 300 volts or less—24 inches; more than 300 volts—30 inches.

(iii) Communication conductors below power conductors with power conductors 300 volts or less—24 inches; more than 300 volts—30 inches.

(2) *Clearance from ground.* Open conductors shall conform to the following minimum clearances:

(i) 10 feet—above finished grade, sidewalks, or from any platform or projection from which they might be reached.

(ii) 12 feet—over areas subject to vehicular traffic other than truck traffic.

(iii) 15 feet—over areas other than those specified in paragraph (c)(2)(iv) of this section that are subject to truck traffic.

(iv) 18 feet—over public streets, alleys, roads, and driveways.

(3) *Clearance from building openings.* Conductors shall have a clearance of at least 3 feet from windows, doors, porches, fire escapes, or similar locations. Conductors run above the top level of a window are considered to be out of reach from that window and, therefore, do not have to be 3 feet away.

(4) *Clearance over roofs.* Conductors shall have a clearance of not less than 8 feet from the highest point of roofs over which they pass, except that

(i) Where the voltage between conductors is 300 volts or less and the roof has a slope of not less than 4 inches in 12, the clearance from roofs shall be at least 3 feet, or

(ii) Where the voltage between conductors is 300 volts or less and the conductors do not pass over more than 4 feet of the overhang portion of the roof and they are terminated at a through-the-roof raceway or approved support, the clearance from roofs shall be at least 18 inches.

(5) *Location of outdoor lamps.* Lamps for outdoor lighting shall be located below all live 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.

(d) *Services. (1) Disconnecting means. (i) General.* Means shall be provided to disconnect all conductors in a building or other structure from the service-entrance conductors. The 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) *Simultaneous opening of poles.* Each service disconnecting means shall simultaneously disconnect all ungrounded conductors.

(2) *Services over 600 volts, nominal.* The following additional requirements apply to services over 600 volts, nominal.

(i) *Guarding.* Service-entrance conductors installed as open wires shall be guarded to make them accessible only to qualified persons.

(ii) *Warning signs.* Signs warning of high voltage shall be posted where other than qualified employees might come in contact with live parts.

(e) *Overcurrent protection. (1) 600 volts, nominal, or less.* The following requirements apply to overcurrent protection of circuits rated 600 volts, nominal, or less.

(i) *Protection of conductors and equipment.* Conductors and equipment shall be protected from overcurrent in accordance with their ability to safely conduct current.

(ii) *Grounded conductors.* 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) *Disconnection of fuses and thermal cutouts.* Except for service fuses, all cartridge fuses which are accessible to other than qualified persons and all fuses and thermal cutouts on circuits over 150 volts to ground shall be provided with disconnecting means. This disconnecting means shall be installed so that the fuse or thermal cutout can be disconnected from its supply without disrupting service to equipment and circuits unrelated to those protected by the overcurrent device.

(iv) *Location in or on premises.* 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 nor in the vicinity of easily ignitible material.

(v) *Arcing or suddenly moving parts.* Fuses and circuit breakers shall be so located or shielded that employees will not be burned or otherwise injured by their operation.

(vi) *Circuit breakers.* (*a*) Circuit breakers shall clearly indicate whether they are in the open (off) or closed (on) position.

(*b*)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. (See § 1910.302(b)(3).)

(*c*) If used as switches in 120-volt, fluorescent lighting circuits, circuit breakers shall be approved for the purpose and marked "SWD." (See § 1910.302(b)(3).)

(2) *Over 600 volts, nominal.* Feeders and branch circuits over 600 volts, nominal, shall have short-circuit protection.

(f) *Grounding.* Paragraphs (f)(1) through (f)(7) of this section contain grounding requirements for systems, circuits, and equipment.

(1) *Systems to be grounded.* The following systems which supply premises wiring shall be grounded:

(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; or

(*b*) They are rectifier-derived from an AC system complying with paragraphs (f)(1)(iii), (f)(1)(v), and (f)(1)(v) of this section; or

(*c*) They are fire-protective signaling 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 (f)(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 480Y/277 volt, 3-phase, 4-wire in which the neutral is used as a circuit conductor;

(*c*) If the system is nominally rated 240/120 volt, 3-phase, 4-wire 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 assure 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.

(2) *Conductors to be grounded.* For AC premises wiring systems the identified conductor shall be grounded.

(3) *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 which do not have an equipment grounding conductor, grounding-type receptacles may be grounded to a grounded cold water pipe near the equipment.

(4) *Grounding path.* The path to ground from circuits, equipment, and enclosures shall be permanent and continuous.

(5) *Supports, enclosures, and equipment to be grounded.*—(i) *Supports and enclosures for conductors.* 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; or

(*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 25 feet; (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) *Service equipment enclosures.* Metal enclosures for service equipment shall be grounded.

(iii) *Frames of ranges and clothes dryers.* Frames of electric ranges, wall-mounted ovens, counter-mounted cooking units, clothes dryers, and metal outlet or junction boxes which are part of the circuit for these appliances shall be grounded.

(iv) *Fixed equipment.* Exposed non-current-carrying metal parts of fixed equipment which may become energized shall be grounded under any of the following conditions:

(*a*) If within 8 feet vertically or 5 feet 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.

(*f*) If equipment operates with any terminal at over 150 volts to ground; however, the following need not be grounded:

(*1*) Enclosures for switches or circuit breakers used for other than service equipment and accessible to qualified persons only;

(*2*) Metal frames of electrically heated appliances which are permanently and effectively insulated from ground; and

(*3*) The cases of distribution apparatus such as transformers and capacitors mounted on wooden poles at a height exceeding 8 feet above ground or grade level.

(v) *Equipment connected by cord and plug.* Under any of the conditions described in paragraphs (f)(5)(v)(*a*) through (f)(5)(v)(*c*) of this section, exposed non-current-carrying metal parts of cord- and plug-connected equipment which may become energized shall be grounded.

(*a*) If in hazardous (classified) locations (see § 1910.306).

(*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 electrical aquarium equipment;

(*3*) Hand-held motoroperated tools;

(*4*) Motoroperated 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.

Tools likely to be used in wet and conductive locations need not be grounded if supplied through an isolating transformer with an ungrounded secondary of not over 50 volts. Listed or labeled portable tools and appliances protected by an approved system of double insulation, or its equivalent, need not be grounded. If such a system is employed, the equipment shall be distinctively marked to indicate that the tool or appliance utilizes an approved system of double insulation.

(vi) *Nonelectrical equipment.* The metal parts of the following nonelectrical equipment shall be grounded: frames and tracks of electrically operated cranes; 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.

(6) *Methods of grounding fixed equipment.* (i) Non-current-carrying metal parts of fixed equipment, if required to be grounded by this subpart, shall be grounded by an equipment grounding conductor which 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 shall be 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 non-current-carrying metal parts of fixed equipment in paragraph (f)(6)(i) of this section. For installations made before April 16, 1981, only, electric equipment shall be also considered to be effectively grounded if it is secured to, and in metallic contact with, the grounded structural metal frame of a building. 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.

(7) *Grounding of systems and circuits of 1000 volts and over (high voltage.).*— (i) *General.* If high voltage systems are grounded, they shall comply with all applicable provisions of paragraphs (f)(1) through (f)(6) of this section as supplemented and modified by this paragraph (f)(7).

(ii) *Grounding of systems supplying portable or mobile equipment.* (See § 1910.302(b)(3).) Systems supplying portable or mobile high voltage equipment, other than substations installed on a temporary basis, shall comply with the following:

(*a*) Portable and mobile high voltage equipment shall be supplied from a system having 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 non-current-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 de-energize any high voltage system component which has developed a ground fault. The continuity of the equipment grounding conductor shall be continuously monitored so as to de-energize 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 or mobile equipment system neutral impedance is connected shall be isolated from and separated in the ground by at least 20 feet from any other system or equipment grounding electrode, and there shall be no direct connection between the grounding electrodes, such as buried pipe, fence, etc.

(iii) *Grounding of equipment.* All non-current-carrying metal parts of portable equipment and fixed equipment including their associated fences, housings, enclosures, and supporting structures shall be grounded. However, equipment which is guarded by location and isolated from ground need not be grounded. Additionally, pole-mounted distribution apparatus at a height exceeding 8 feet 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 the conductors that are an integral part of factory-assembled equipment.

(1) *General requirements.*—(i) *Electrical continuity of metal raceways and enclosures.* Metal raceways, cable armor, and othe metal enclosures for conductors shall be metallically joined together into a continuous electric conductor and shall be so connected to all boxes, fittings, and cabinets as to provide effective electrical continuity.

(ii) *Wiring in ducts.* No wiring systems of any type shall 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.* Temporary electrical power and lighting wiring methods may be of a class less than would be required for a permanent installation. Except as specifically modified in this paragraph, all other requirements of this subpart for permanent wiring shall apply to temporary wiring installations.

(i) *Uses permitted, 600 volts, nominal, or less.* Temporary electrical power and lighting installations 600 volts, nominal, or less may be used only:

(*a*) During and for remodeling, maintenance, repair, or demolition of buildings, structures, or equipment, and similar activities;

(*b*) For experimental or development work, and

(*c*) For a period not to exceed 90 days for Christmas decorative lighting, carnivals, and similar purposes.

(ii) *Uses permitted, over 600 volts, nominal.* Temporary wiring over 600 volts, nominal, may be used only during periods of tests, experiments, or emergencies.

(iii) *General requirements for temporary wiring.—(a)* Feeders shall originate in an approval distribution center. The conductors shall be run as multiconductor cord or cable assemblies, or, where not subject to physical damage, they may be run as open conductors on insulators not more than 10 feet apart.

(*b*) Branch circuits shall originate in an approved power outlet or panelboard. Conductors shall be multiconductor cord or cable assemblies or open conductors. If run as open conductors they shall be fastened at ceiling height every 10 feet. No branch-circuit conductor may be laid on the floor. Each branch circuit that supplies receptacles or fixed equipment shall contain a separate equipment grounding conductor if run as open conductors.

(*c*) Receptacles shall be of the grounding type. Unless installed in a complete metallic raceway, each branch circuit shall contain a separate equipment grounding conductor and all receptacles shall be electrically connected to the grounding conductor.

(*d*) No bare conductors nor earth returns may be used for the wiring of any temporary circuit.

(*e*) Suitable disconnecting switches or plug connectors shall be installed to permit the disconnection of all ungrounded conductors of each temporary circuit.

(*f*) Lamps for general illumination shall be protected from accidential contact or breakage. Protection shall be provided by elevation of at least 7 feet from normal working surface or by a suitable fixture of lampholder with a guard.

(*g*) Flexible cords and cables shall be protected from accidental damage. Sharp corners and projections shall be avoided. Where passing through doorways or other pinch points, flexible cords and cables shall be provided with protection to avoid damage.

(3) *Cable trays.* (i) *Uses permitted. (a)* Only the following may be installed in cable tray systems:

(*1*) Mineral-insulated metal-sheathed cable (Type MI);

(*2*) Armored cable (Type AC);

(*3*) Metal-clad cable (Type MC);

(*4*) Power-limited tray cable (Type PLTC);

(*5*) Nonmetallic-sheathed cable (Type NM or NMC);

(*6*) Shielded Nonmetallic-sheathed cable (Type SNM);

(*7*) Multiconductor service-entrance cable (Type SE or USE);

(*8*) Multiconductor underground feeder and branch-circuit cable (Type UF);

(*9*) Power and control tray cable (Type TC);

(*10*) Other factory-assembled, multiconductor control, signal, or power cables which are specifically approved for installation in cable trays; or

(*11*) Any approved conduit or raceway with its contained conductors.

(*b*) In industrial establishments only, 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 4 inch ventilated channel-type cable trays:

(*1*) Single conductor cables which are 250 MCM or larger and are Types RHH, RHW, MV, USE, or THW, and 250 MCM or larger single conductor cables if specifically approved for installation in cable trays. Where exposed to direct rays of the sun, cables shall be sunlight-resistant.

(*2*) Type MV cables, where exposed to direct rays of the sun, shall be sunlight-resistant.

(*c*) Cable trays in hazardous (classified) locations shall contain only the cable types permitted in such locations.

(ii) *Uses not permitted.* Cable tray systems may not be used in hoistways or where subjected to severe physical damage.

(4) *Open wiring on insulators.*—(i) *Uses permitted.* Open wiring on insulators is only permitted on systems of 600 volts, nominal, or less for industrial or agricultural establishments and for services.

(ii) *Conductor supports.* Conductors shall be rigidly supported on noncombustible, nonabsorbent insulating materials and may not contact any other objects.

(iii) *Flexible nonmetallic tubing.* 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 15 feet and secured to the surface by straps at intervals not exceeding 4 feet 6 inches.

(iv) *Through walls, floors, wood cross members, etc.* 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) *Protection from physical damage.* Conductors within 7 feet from the floor are considered exposed to physical damage. Where open conductors cross ceiling joints and wall studs and are exposed to physical damage, they shall be protected.

(b) *Cabinets, boxes, and fittings.*—(1) *Conductors entering boxes, cabinets, or fittings.* Conductors entering boxes, cabinets, or fittings shall be protected from abrasion, and openings through which conductors enter shall be effectively closed. Unused openings in cabinets, boxes, and fittings shall be also effectively closed.

(2) *Covers and canopies.* All pull boxes, junction boxes, and fittings shall be provided with covers approved 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.

(3) *Pull and junction boxes for systems over 600 volts, nominal.* In addition to other requirements in this section for pull and junction boxes, the following shall apply to these 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. Underground box covers that weigh over 100 pounds meet this requirement. 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) *Knife switches.* Single-throw knife switches shall be so connected that the blades are dead when the switch is in the open position. 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. 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.

(2) *Faceplates for flush-mounted snap switches.* Flush snap switches that are mounted in ungrounded metal boxes and located within reach of conducting floors or other conducting surfaces shall be provided with faceplates of nonconducting, noncombustible material.

(d) *Switchboards and panelboards.* Switchboards that have any exposed live parts shall be located in permanently dry locations and accessible only to qualified persons. Panelboards shall be mounted in cabinets, cutout boxes, or enclosures approved 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. Exposed blades of knife switches shall be dead when open.

(e) *Enclosures for damp or wet locations.* (1) 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. In wet locations the enclosures shall be weatherproof.

(2) Switches, circuit breakers, and switchboards installed in wet locations shall be enclosed in weatherproof enclosures.

(f) *Conductors for general wiring.* All conductors used for general wiring shall be insulated unless otherwise permitted in this Subpart. The conductor insulation shall be of a type that is approved for the voltage, operating temperature, and location of use. 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 and suitable for conditions of use and location. Flexible cords and cables shall be used only for:

(*a*) Pendants;

(*b*) Wiring of fixtures;

(*c*) Connection of portable lamps or appliances;

(*d*) Elevator cables;

(*e*) Wiring of cranes and hoists;

(*f*) Connection of stationary equipment to facilitate their frequent interchange;

(*g*) Prevention of the transmission of noise or vibration;

(*h*) Appliances where the fastening means and mechanical connections are designed to permit removal for maintenance and repair; or

(*i*) Data processing cables approved as a part of the data processing system.

(ii) If used as permitted in paragraphs (g)(1)(i)(*c*), (g)(1)(i)(*f*), or (g)(1)(i)(*h*) of this section, the flexible cord shall be equipped with an attachment plug and shall be energized from an approved receptacle outlet.

(iii) Unless specifically permitted in paragraph (g)(1)(i) 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; or

(*e*) Where concealed behind building walls, ceilings, or floors.

(iv) Flexible cords used to show windows and showcases shall be Type S, SO, SJ, SJO, ST, STO, SJT, SJTO, or AFS 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 SJ, SJO, SJT, SJTO, S, SO, ST, and STO shall be durably marked on the surface with the type designation, size, and number of conductors.

(ii) Flexible cords shall be used only in continuous lengths without splice or tap. Hard service flexible cords No. 12 or 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 shall be connected to devices and fittings so that strain relief is provided which will prevent pull from being directly transmitted to joints or terminal screws.

(h) *Portable cables over 600 volts, nominal.* 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. Cables operated at over 2,000 volts shall be shielded for the purpose of confining the voltage stresses to the insulation. Grounding conductors shall be provided. Connectors for these cables shall be of a locking type with provisions to prevent their opening or closing while energized. Strain relief shall be provided at connections and terminations. Portable cables may not be operated with splices unless the splices are of the permanent molded, vulcanized, or other approved type. Termination enclosures shall be suitably marked with a high voltage hazard warning, and terminations shall be accessible only to authorized and qualified personnel.

(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:

(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.

(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 8 feet above the floor may have exposed parts.

(ii) Handlamps of the portable type supplied through flexible cords shall be equipped with a handle of molded composition or other material approved for the purpose, and a substantial guard shall be attached to the lampholder or the handle.

(iii) Lampholders of the screw-shell type shall be installed for use as lampholders only. Lampholders installed in wet or damp locations shall be of the weatherproof type.

(iv) Fixtures installed in wet or damp locations shall be approved 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) 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.

(ii) A receptacle installed in a wet or damp location shall be suitable for the location.

(3) *Appliances.*—(i) Appliances, other than those in which the current-carrying parts at high temperatures are necessarily exposed, may have no live parts normally exposed to employee contact.

(ii) A means shall be provided to disconnect each appliance.

(iii) Each appliance shall be marked with its rating in volts and amperes or volts and watts.

(4) *Motors.* This paragraph applies to motors, motor circuits, and controllers.

(i) *In sight from.* If specified that one piece of equipment shall be "in sight from" another piece of equipment, one shall be visible and not more than 50 feet from the other.

(ii) *Disconnecting means.* (*a*) A disconnecting means shall be located in sight from 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 which is to be locked in the open position.

(*b*) 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.

(*c*) If a motor and the driven machinery are not in sight from the controller location, the installation shall comply with one of the following conditions:

(*1*) The controller disconnecting means shall be capable of being locked in the open position.

(*2*) A manually operable switch that will disconnect the motor from its source of supply shall be placed in sight from the motor location.

(*d*) The disconnecting means shall plainly indicate whether it is in the open (off) or closed (on) position.

(*e*) The disconnecting means shall be readily accessible. If more than one disconnect is provided for the same equipment, only one need be readily accessible.

(*f*) 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:

(*1*) If a number of motors drive special parts of a single machine or piece of apparatus, such as metal and woodworking machines, cranes, and hoists;

(*2*) If a group of motors is under the protection of one set of branch-circuit protective devices; or

(*3*) If a group of motors is in a single room in sight from the location of the disconnecting means.

(iii) *Motor overload, short-circuit, and ground-fault protection.* 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 shall 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.

(iv) *Protection of live parts—all voltages.*—(*a*) Stationary motors having commutators, collectors, and brush rigging located inside of motor end brackets and not conductively connected to supply circuits operating at more than 150 volts to ground need not have such parts guarded. Exposed live parts of motors and controllers operating at 50 volts or more between terminals shall be guarded against accidental contact by any of the following:

(*1*) By installation in a room or enclosure that is accessible only to qualified persons;

(*2*) By installation on a suitable balcony, gallery, or platform, so elevated and arranged as to exclude unqualified persons; or

(*3*) By elevation 8 feet or more above the floor.

(*b*) 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) The following paragraphs cover 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 which 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-protective signalling 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 warning 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) If they present a fire hazard to employees, oil-insulated transformers installed indoors shall be in a vault.

(v) Combustible material, combustible buildings and parts of buildings, fire escapes, and door and window openings shall be safeguarded from fires which 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 vault installation may not enter or pass through a transformer vault.

(viii) Materials 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) Capacitors rated over 600 volts, nominal, shall comply with the following additional requirements:

(a) 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.

(b) For series capacitors (see § 1910.302(b)(3)), 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 battiers. 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.* Signs operated by electronic or electromechanical controllers located outside the sign shall have a disconnecting means located inside the controller enclosure or within sight of the controller location, and it shall be capable of being locked in the open position. Such disconnecting means shall have no pole that can be operated independently, and it shall open all ungrounded conductors that supply the controller and sign. All other signs, except the portable type, and all outline lighting installations shall have an externally operable disconnecting means which can open all underground conductors and is within the sight of the sign or outline lighting it controls.

(2) 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 oridinary 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.* A readily accessible disconnecting means shall be provided between the runway contact conductors and the power supply.

(ii) Another disconnecting means, capable of being locked in the open position, shall be provided in the leads from the runway contact conductors or other power supply on any crane or monorail hoist.

(a) If this additional disconnecting means is not readily accessible from the crane or monorail hoist operating station, means shall be provided at the operating station to open the power circuit to all motors of the crane or monorail hoist.

(b) The additional disconnect may be omitted if a monorail hoist or hand-propelled crane bridge installation meets all of the following:

(1) The unit is floor controlled;

(2) The unit is within view of the power supply disconnecting means; and

(3) No fixed work platform has been provided for servicing the unit.

(2) *Control.* 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.

(3) *Clearance.* The dimension of the working space in the direction of access to live parts which may require examination, adjustment, servicing, or maintenance while alive shall be a minimum of 2 feet 6 inches. Where controls are enclosed in cabinets, the door(s) shall either open at least 90 degrees or be removable.

(c) *Elevators, dumbwaiters, escalators, and moving walks.* (1) *Disconnecting means.* Elevators, dumbwaiters, escalators, and moving walks shall have a single means for disconnecting all underground main power supply conductors for each unit.

(2) *Warning signs.* If interconnections between control panels are necessary for operation of the system on a multicar installation that remains energized from a source other than the disconnecting means, a warning sign shall be mounted on or adjacent to the disconnecting means. The sign shall be clearly legible and shall read "Warning—Parts of the control panel are not de-energized by this switch." (See § 1910.302(b)(3).)

(3) *Control panels.* If control panels are not located in the same space as the drive machine, they shall be located in cabinets with doors or panels capable of being locked closed.

(d) *Electric welders—disconnecting means.* (1) A disconnecting means shall be provided in the supply circuit for each motor-generator arc welder, and for each AC transformer and DC rectifier arc welder which is not equipped with a disconnect mounted as an intergral part of the welder.

(2) A switch or circuit breaker shall be provided by which each resistance welder and its control equipment can be isolated from the supply circuit. The ampere rating of this disconnecting means may not be less than the supply conductor ampacity.

(e) *Data processing systems—disconnecting means.* A disconnecting means shall be provided to disconnect the power to all electronic equipment in data processing or computer rooms. This disconnecting means shall be controlled from locations readily accessible to the operator at the principal exit doors. There shall also be a similar disconnecting means to disconnect the air conditioning system serving this area.

(f) *X-Ray equipment.* This paragraph applies to X-ray equipment for other than medical or dental use.

(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. This disconnecting means shall be constructed, enclosed, or located so as to avoid contact by employees with its live parts.

(2) *Control.* (i) *Radiographic and fluoroscopic types.* Radiographic and fluoroscopic-type equipment shall be effectively enclosed or shall have interlocks that de-energize the equipment automatically to prevent ready access to live current-carrying parts.

(ii) *Diffraction and irradiation types.* Diffraction- and irradiation-type equipment shall be provided with a means to indicate when it 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.* (1) *Scope.* Paragraphs (g)(2) and (g)(3) of this section cover induction

and dielectric heating equipment and accessories for industrial and scientific applications, but not for medical or dental applications or for appliances.

(2) *Guarding and grounding.* (i) *Enclosures.* 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 or noncombustible material.

(ii) *Panel controls.* All panel controls shall be of dead-front construction.

(iii) *Access to internal equipment.* Where doors are used for access to voltages from 500 to 1000 volts AC or DC, either door locks or interlocks shall be provided. Where doors are used for access to voltages of over 1000 volts AC or DC, either mechanical lockouts with a disconnecting means to prevent access until voltage is removed from the cubicle, or both door interlocking and mechanical door locks, shall be provided.

(iv) *Warning labels.* "Danger" labels shall be attached on the equipment and shall be plainly visible even when doors are open or panels are removed from compartments containing voltages of over 250 volts AC or DC.

(v) *Work applicator shielding.* Protective cages or adequate shielding shall be used to guard work applicators other than induction heating coils. Induction heating coils shall be protected by insulation and/or refractory materials. Interlock switches shall be used on all hinged access doors, sliding panels, or other such means of access to the applicator. 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. Interlocks on access doors or panels are not required if the applicator is an induction heating coil at DC ground potential or operating at less than 150 volts AC.

(vi) *Disconnecting means.* A readily accessible disconnecting means shall be provided by which each unit of heating equipment can be isolated from its supply circuit.

(3) *Remote control.* 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. 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.* (1) *Scope.* These provisions for electrolytic cells apply to the installation of the electrical components and accessory equipment or 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 these provisions.

(2) *Definitions applicable to this paragraph.*

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; duct work; structural supports; exposed cell line conductors; conduits and other raceways; pumps; positioning equipment and cell cutout or by-pass 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.

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 cell lines or their attachments.

Electrolytic Cells: A receptacle or vessel in which electrochemical reactions are caused by applying energy for the purpose of refining or producing usable materials.

(3) *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(e).

(ii) Equipment located or used within the cell line working associated with the cell line DC power circuits need not comply with the provisions of § 1910.304(f).

(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, and 1910.304 (b) and (c).

(4) *Disconnecting means.* (i) 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.

(ii) Removable links or removable conductors may be used as the disconnecting means.

(5) *Portable electric equipment.* (i) The frames and enclosures of portable electric equipment used within the cell line working zone may not be grounded. However, these frames and enclosures may be grounded if the cell line circuit voltage does not exceed 200 volts DC or if the frames are guarded.

(ii) Ungrounded portable electric equipment shall be distinctively marked and may not be interchangeable with grounded portable electric equipment.

(6) *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 be electrically isolated from any distribution system supplying areas other than the cell line working zone and shall be ungrounded. Power for these circuits shall be supplied through isolating transformers.

(ii) Receptacles and their mating plugs for ungrounded equipment may not have provision for a grounding conductor and shall be of a configuration which prevents their use for equipment required to be grounded.

(iii) Receptacles on circuits supplied by an isolating transformer with an ungrounded secondary shall have a distinctive configuration, shall be distinctively marked, and may not be used in any other location in the plant.

(7) *Fixed and portable electric equipment.* (i) AC systems supplying fixed and portable electric equipment within the cell line working zone need not be grounded.

(ii) Exposed conductive surfaces, such as electric equipment housing, cabinets, boxes, motors, raceways and the like that are within the cell line working zone need not be grounded.

(iii) Auxiliary electrical devices, such as motors, transducers, sensors, control devices, and alarms, mounted on an electrolytic cell or other energized surface, shall be connected by any of the following means:

(*a*) Multiconductor hard usage or extra hard usage flexible cord;

(*b*) Wire or cable in suitable raceways; or

(*c*) Exposed metal conduit, cable tray, armored cable, or similar metallic systems installed with insulating breaks such that they will not cause a potentially hazardous electrical condition.

(iv) 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.

(8) *Auxiliary nonelectric connections.* Auxiliary nonelectric 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, and the like. Hoses shall be of a nonconductive material.

(9) *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 which contacts an energized electrolytic cell or energized attachments shall be insulated from ground.

(ii) Remote crane or hoist controls which may introduce hazardous electrical conditions into the cell line working zone shall employ one or more of the following systems:

(*a*) Insulated and ungrounded control circuit;

(*b*) Nonconductive rope operator;

(*c*) Pendant pushbutton with nonconductive supporting means and having nonconductive surfaces or ungrounded exposed conductive surfaces; or

(*d*) Radio.

(i) *Electrically driven or controlled irrigation machines.* (See § 1910.302(b)(3).)

(1) *Lightning protection.* If an electrically driven or controlled irrigation machine has a stationary point, a driven ground rod shall be connected to the machine at the stationary point for lightning protection.

(2) *Disconnecting means.* The main disconnecting means for a center pivot irrigation machine shall be located at the point of connection of electrical power to the machine and shall be readily accessible and capable of being locked in the open position. A disconnecting means shall be provided for each motor and controller.

(j) *Swimming pools, fountains, and similar installations.* (1) *Scope.* Paragraphs (j)(2) through (j)(5) of this section apply to electric wiring for and equipment in or adjacent to all swimming, wading, therapeutic, and decorative pools and fountains, whether permanently installed or storable, and to metallic auxiliary equipment, such as pumps, filters, and similar equipment. Therapeutic pools in health care facilities are exempt from these provisions.

(2) *Lighting and receptacles.* (i) *Receptacles.* 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 5 feet from the inside walls of a pool. All other receptacles on the property shall be located at least 10 feet from the inside walls of a pool. Receptacles which are located within 15 feet of the inside walls of the pool shall be protected by ground-fault circuit interrupters.

Note.—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.

(ii) *Lighting fixtures and lighting outlets.* (*a*) Unless they are 12 feet above the maximum water level, lighting fixtures and lighting outlets may not be installed over a pool or over the area extending 5 feet horizontally from the inside walls of a pool. However, a lighting fixture or lighting outlet which has been installed before April 16, 1981 may be located less than 5 feet measured horizontally from the inside walls of a pool if it is at least 5 feet above the surface of the maximum water level and shall be 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.

(*b*) Unless installed 5 feet above the maximum water level and rigidly attached to the structure adjacent to or enclosing the pool, lighting fixtures and lighting outlets installed in the area extending between 5 feet and 10 feet horizontally from the inside walls of a pool shall be protected by a ground-fault circuit interrupter.

(3) *Cord- and plug-connected equipment.* Flexible cords used with the following equipment may not exceed 3 feet 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 16 feet of the water surface of permanently installed pools.

(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 approved for the purpose.

(ii) No underwater lighting fixtures may be installed for operation at over 150 volts between conductors.

(5) *Fountains.* All electric equipment operating at more than 15 volts, including power supply cords, used with fountains shall be protected by ground-fault circuit interrupters. (See § 1910.302(b)(3).)

§ 1910.307 Hazardous (classified) locations.

(a) *Scope.* This section covers the requirements for electric equipment and wiring in locations which are classified depending on the properties of the flammable vapors, liquids or gases, or combustible dusts or fibers which 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. These hazardous (classified) locations are assigned six designations as follows:

Class I, Division 1
Class I, Division 2
Class II, Division 1
Class II, Division 2
Class III, Division 1
Class III, Division 2

For definitions of these locations see § 1910.399(a). All applicable requirements in this subpart shall apply to hazardous (classified) locations, unless modified by provisions of this section.

(b) *Electrical installations.* Equipment, wiring methods, and installations of equipment in 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 shall be 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 ignitible or combustible properties of the specific gas, vapor, dust, or fiber that will be present.

Note.—NFPA 70, the National Electrical Code, lists or defines hazardous gases, vapors, and dusts by "Groups" characterized by their ignitible 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 degrees C ambient, for which it is approved. The temperature marking shall 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 non-heat-producing type, such as junction boxes, conduit, and fittings, and equipment of the heat-producting type having a maximum temperature not more than 100 degrees C (212 degrees F), need not have a marked operating temperature or temperature range.

(*b*) Fixed lighting fixtures marked for use in Class I, 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, which 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, which 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.

(3) *Safe for the hazardous (classified) location.* Equipment which is safe for the location shall be of a type and design which the employer demonstrates will provide protection from the hazards arising from the combustibility and flammability of vapors, liquids, gases, dusts, or fibers.

Note.—The National Electrical Code, NFPA 70, contains guidelines for determining the type and design of equipment and installations which will meet this requirement. The guidelines of this document 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. Compliance with these guidelines will constitute one means, but not the only means, of compliance with this paragraph.

(c) *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.

(d) *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 equipment does not constitute a source of ignition under normal operating conditions.

§ 1910.308 Special systems.

(a) *Systems over 600 volts, nominal.* Paragraphs (a)(1) through (a)(4) of this section cover the general requirements for all circuits and equipment operated at over 600 volts.

(1) *Wiring methods for fixed installations.* (i) Above-ground conductors shall be installed in rigid metal conduit, in intermediate metal conduit, in cable trays, in cablebus, in other suitable raceways, or as open runs of metal-clad cable suitable for the use and purpose. However, open runs of non-metallic-sheathed cable or of bare conductors or busbars may be installed in locations accessible only to qualified persons. Metallic shielding components, such as tapes, wires, or braids for conductors, shall be grounded. 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. (See § 1910.302(b)(3).)

(2) *Interrupting and isolating devices.* (i) Circuit breakers located indoors shall consist of metal-enclosed or fire-resistant, cell-mounted units. In locations accessible only to qualified personnel, open mounting of circuit breakers is permitted. A means of indicating the open and closed position of circuit breakers shall be provided.

(ii) Fused cutouts installed in buildings or tranformer vaults shall be of a type approved for the purpose. They shall be readily accessible for fuse replacement.

(iii) A means shall be provided to completely isolate equipment for inspection and repairs. Isolating means which are not designed to interrupt the load curent of the circuit shall be either interlocked with an approved circuit interrupter or provided with a sign warning against opening them under load.

(3) *Mobile and portable equipment.* (i) *Power cable connections to mobile machines.* 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 ground wire(s) 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) *Guarding live parts.* 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.

(4) *Tunnel installations.* (i) *Application.* The provisions of this paragraph apply to installation and use of high-voltage power distribution and utilization equipment which is portable and/or mobile, such as substations, trailers, cars, mobile shovels, draglines, hoists, drills, dredges, compressors, pumps, conveyors, and underground excavators.

(ii) *Conductors.* 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.

Conductors shall also be so located or guarded as to protect them from physical damage. Multiconductor portable cable may supply mobile equipment. 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.

(iii) *Guarding live parts.* Bare terminals of transformers, switches, motor controllers, and other equipment shall be enclosed to prevent accidental contact with energized parts. Enclosures for use in tunnels shall be drip-proof, weatherproof, or submersible as required by the environmental conditions.

(iv) *Disconnecting means.* A disconnecting means that simultaneously opens all ungrounded conductors shall be installed at each transformer or motor location.

(v) *Grounding and bonding.* 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 1000 feet throughout the tunnel.

(b) *Emergency power systems.* (1) *Scope.* The provisions for emergency systems apply to circuits, systems, and equipment intended to supply power for illumination and special loads, in the event of failure of the normal supply.

(2) *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 with 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.

(3) *Emergency 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.

(c) *Class 1, Class 2, and Class 3 remote control, signaling, and power-limited circuits.* (1) *Classification.* Class 1, Class 2, or Class 3 remote control, signaling, or power-limited circuits are characterized by their usage and electrical power limitation which 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) *Class 1 circuits. (a)* A Class 1 power-limited circuit is supplied from a source having a rated output of not more than 30 volts and 1000 volt-amperes.

(b) A Class 1 remote control circuit or a Class 1 signaling circuit has a voltage which does not exceed 600 volts; however, the power output of the source need not be limited.

(ii) *Class 2 and Class 3 circuits. (a)* Power for Class 2 and Class 3 circuits is limited either inherently (in which no overcurrent protection is required) or by a combination of a power source and overcurrent protection.

(b) The maximum circuit voltage is 150 volts AC or DC for a Class 2 inherently limited power source, and 100 volts AC or DC for a Class 3 inherently limited power source.

(c) The maximum circuit voltage is 30 volts AC and 60 volts DC for a Class 2 power source limited by overcurrent protection, and 150 volts AC or DC for a Class 3 power source limited by overcurrent protection.

(iii) The maximum circuit voltages in paragraphs (c)(1)(i) and (c)(1)(ii) of this section apply to sinusoidal AC or continuous DC power sources, and where wet contact occurence is not likely.

(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. (See § 1910.302(b)(3).)

(d) *Fire protective signaling systems.* (See § 1910.302(b)(3).)

(1) *Classifications.* Fire protective signaling circuits shall be classified either as non-power limited or power limited.

(2) *Power sources.* The power sources for use with fire protective signaling circuits shall be either power limited or nonlimited as follows:

(i) The power supply of non-power-limited fire protective signaling circuits shall have an output voltage not in excess of 600 volts.

(ii) The power for power-limited fire protective signaling circuits shall be either inherently limited, in which no overcurrent protection is required, or limited by a combination of a power source and overcurrent protection.

(3) *Non-power-limited conductor location.* Non-power-limited fire protective signaling 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 protective signaling circuit conductors are permitted in the same enclosure, cable, or raceway only if connected to the same equipment.

(4) *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. Cables and conductors of two or more power-limited fire protective signaling circuits or Class 3 circuits are permitted in the same cable, enclosure, or raceway. Conductors of one or more Class 2 circuits are permitted within the same cable, enclosure, or raceway with conductors of power-limited fire protective signaling 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 protective signaling circuits.

(5) *Identification.* Fire protective signaling circuits shall be identified at terminal and junction locations in a manner which will prevent unintentional interference with the signaling circuit during testing and servicing. Power-limited fire protective signaling circuits shall be durably marked as such where plainly visible at terminations.

(e) *Communications systems.* (1) *Scope.* These provisions for communication systems apply to such systems as 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).

(2) *Protective devices.* (i) Communication circuits so located as to be exposed to accidental contact with light or power conductors operating at over 300 volts shall have each circuit so exposed provided with a protector approved for the purpose.

(ii) Each conductor of a lead-in from an outdoor antenna shall be provided with an antenna discharge unit or other suitable means that will drain static charges from the antenna system.

(3) *Conductor location.* (i) *Outside of buildings. (a)* Receiving distribution lead-in or aerial-drop cables attached to buildings and lead-in conductors to radio transmitters shall be so installed as to avoid the possibility of accidental contact with electric light or power conductors.

(b) The clearance between lead-in conductors and any lightning protection conductors may not be less than 6 feet.

(ii) *On poles.* Where practicable, communication conductors on poles shall be located below the light or power conductors. Communications conductors may not be attached to a crossarm that carries light or power conductors.

(iii) *Inside of buildings.* Indoor antennas, lead-ins, and other communication conductors attached as open conductors to the inside of buildings shall be located at least 2 inches from conductors of any light or power or Class 1 circuits unless a special and equally protective method of conductor separation, approved for the purpose, is employed.

(4) *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 avoid the possibility of the antenna or structure falling into or making accidental contact with such circuits.

(5) *Grounding.* (i) *Lead-in conductors.* 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) *Antenna structures.* Masts and metal structures supporting antennas shall be permanently and effectively grounded without splice or connection in the grounding conductor.

(iii) *Equipment enclosures.* 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 shall be considered grounded where connected to an attached coaxial cable with an effectively grounded metallic shield.

§ 1910.309–§ 1910.330. [Reserved]

Safety-Related Work Practices

§ 1910.331–§ 1910.360. [Reserved]

Safety-Related Maintenance Requirements

§ 1910.361–§ 1910.380 [Reserved]

Safety Requirements for Special Equipment

§ 1910.381–§ 1910.398 [Reserved]

Definitions

§ 1910.399 Definitions applicable to this subpart.

(a) *Definitions applicable to §§ 1910.302 through 1910.330.*

(1) *Acceptable.* An installation or equipment is acceptable to the Assistant Secretary of Labor, and approved within the meaning of this Subpart S: (i) If it is accepted, or certified, or listed, or labeled, or otherwise determined to be safe by a nationally recognized testing laboratory, such as, but not limited to, Underwriters' Laboratories, Inc. and Factory Mutual Engineering Corp.; or (ii) with respect to an installation or equipment of a kind which 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 (iii) with respect to custom-made equipment or related installations which 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.

(2) *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.

(3) *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."*)

(4) *Accessible.* (As applied to equipment.) Admitting close approach; not guarded by locked doors, elevation, or other effective means. (See *"Readily accessible."*)

(5) *Ampacity.* Current-carrying capacity of electric conductors expressed in amperes.

(6) *Appliances.* Utilization equipment, generally other than industrial, normally built in standardized sizes or types, which is installed or connected as a unit to perform one or more functions such as clothes washing, air conditioning, food mixing, deep frying, etc.

(7) *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.

(8) *Approved for the purpose.* 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."*)

(9) *Armored cable.* Type AC armored cable is a fabricated assembly of insulated conductors in a flexible metallic enclosure.

(10) *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.

(11) *Attachment plug (Plug cap) (Cap).* A device which, by insertion in a receptacle, establishes connection between the conductors of the attached flexible cord and the conductors connected permanently to the receptacle.

(12) *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.

(13) *Bare conductor.* See *"Conductor."*

(14) *Bonding.* The permanent joining of metallic parts to form an electrically conductive path which will assure electrical continuity and the capacity to conduct safely any current likely to be imposed.

(15) *Bonding jumper.* A reliable conductor to assure the required electrical conductivity between metal parts required to be electrically connected.

(16) *Branch circuit.* The circuit conductors between the final overcurrent device protecting the circuit and the outlet(s).

(17) *Building.* A structure which stands alone or which is cut off from adjoining structures by fire walls with all openings therein protected by approved fire doors.

(18) *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 may be hung.

(19) *Cable tray system.* A cable tray system is a unit or assembly of units or sections, and associated fittings, made of metal or other noncombustible materials forming a rigid structural system used to support cables. Cable tray systems include ladders, troughs, channels, solid bottom trays, and other similar structures.

(20) *Cablebus.* Cablebus is an approved assembly of insulated conductors with fittings and conductor terminations in a completely enclosed, ventilated, protective metal housing.

(21) *Center pivot irrigation machine.* A center pivot irrigation machine is a multi-motored irrigation machine which

revolves around a central pivot and employs alignment switches or similar devices to control individual motors.

(22) *Certified.* Equipment is "certified" if it (a) 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 (b) is of a kind whose production is periodically inspected by a nationally recognized testing laboratory, and (c) it bears a label, tag, or other record of certification.

(23) *Circuit breaker.* (i) (600 volts nominal, or less). A device designed to open and close a circuit by nonautomatic means and to open the circuit automatically on a predetermined overcurrent without injury to itself when properly applied within its rating.

(ii) (Over 600 volts, nominal). A switching device capable of making, carrying, and breaking currents under normal circuit conditions, and also making, carrying for a specified time, and breaking currents under specified abnormal circuit conditions, such as those of short circuit.

(24) *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 ignitible mixtures. Class I locations include the following:

(i) *Class I, Division 1.* 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; or (*b*) in which hazardous concentrations of such gases or vapors may exist frequently because of repair or maintenance operations or because of leakage; or (*c*) in which breakdown or faulty operation of equipment or processes might release hazardous concentrations of flammable gases or vapors, and might also cause simultaneous failure of electric equipment.

Note.—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 ignitible concentrations of flammable vapors or gases are likely to occur in the course of normal operations.

(ii) Class I, Division 2. A Class I, Division 2 location is a location: (*a*) 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 case of accidental rupture or breakdown of such containers or systems, or in case of abnormal operation of equipment; or (*b*) in which hazardous 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 (*c*) that is adjacent to a Class I, Division 1 location, and to which hazardous 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.—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 to be merit considered 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 a 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.

(25) *Class II locations.* Class II locations are those that are hazardous because of the presence of combustible dust. Class II locations include the following:

(i) *Class II, Division 1.* A Class II, Division 1 location is a location: (*a*) in which combustible dust is or may be in suspension in the air under normal operating conditions, in quantities sufficient to produce explosive or ignitible mixtures; or (*b*) where mechanical failure or abnormal operation of machinery or equipment might cause such explosive or ignitible mixtures to be produced, and might also provide a source of ignition through simultaneous failure of electric equipment, operation of protection devices, or from other causes, or (*c*) in which combustible dusts of an electrically conductive nature may be present.

Note.—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 which 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 ignitible mixtures. Combustible dusts which 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 woodflour, 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.

(ii) *Class II, Division 2.* A Class II, Division 2 location is a location in which, (*a*) combustible dust will not normally be in suspension in the air in quantities sufficient to produce explosive or ignitible mixtures; and dust accumulations are normally insufficient to interfere with the normal operation of electrical equipment or other apparatus; or (*b*) Dust may be in suspension in the air as a result of infrequent malfunctioning of handling or processing equipment, and dust accumulations resulting therefrom may be ignitible by abnormal operation or failure of electrical equipment or other apparatus.

Note.—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 operation conditions or be adjacent to a Class II Division 1 location, as described above, into which an explosive or ignitible concentration of dust may be put into suspension under abnormal operating conditions.

(26) *Class III locations.* Class III locations are those that are hazardous because of the presence of easily

ignitible 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 ignitible mixtures. Class III locations include the following:

(i) *Class III, Division 1.* A Class III, Division 1 location is a location in which easily ignitible fibers or materials producing combustible flyings are handled, manufactured, or used.

Note.—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 ignitible 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.

(ii) *Class III, Division 2.* A Class III, Division 2 location is a location in which easily ignitible fibers are stored or handled, except in process of manufacture.

(27) *Collector ring.* A collector ring is an assembly of slip rings for transferring electrical energy from a stationary to a rotating member.

(28) *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.)"]*

(29) *Conductor.* (i) *Bare.* A conductor having no covering or electrical insulation whatsoever.

(ii) *Covered.* A conductor encased within material of composition or thickness that is not recognized as electrical insulation.

(iii) *Insulated.* A conductor encased within material of composition and thickness that is recognized as electrical insulation.

(30) *Conduit body.* A separate portion of a conduit or tubing system that provides access through a removable cover(s) 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.

(31) *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.

(32) *Cooking unit, counter-mounted.* A cooking appliance designed for mounting in or on a counter and consisting of one or more heating elements, internal wiring, and built-in or separately mountable controls. (*See "Oven, wall-mounted."*)

(33) *Covered conductor.* See "Conductor."

(34) *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.

(35) *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.")*

(36) *Damp location.* See *"Location."*

(37) *Dead front.* Without live parts exposed to a person on the operating side of the equipment.

(38) *Device.* A unit of an electrical system which is intended to carry but not utilize electric energy.

(39) *Dielectric heating.* Dielectric heating is the heating of a nominally insulating material due to its own dielectric losses when the material is placed in a varying electric field.

(40) *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.

(41) *Disconnecting (or Isolating) switch.* (Over 600 volts, nominal.) A mechanical switching device used for isolating a circuit or equipment from a source of power.

(42) *Dry location.* See *"Location."*

(43) *Electric sign.* A fixed, stationary, or portable self-contained, electrically illuminated utilization equipment with words or symbols designed to convey information or attract attention.

(44) *Enclosed.* Surrounded by a case, housing, fence or walls which will prevent persons from accidentally contacting energized parts.

(45) *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.

(46) *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.

(47) *Equipment grounding conductor.* See *"Grounding conductor, equipment."*

(48) *Explosion-proof apparatus.* Apparatus enclosed in a case that is capable of withstanding an explosion of a specified gas or vapor which 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 which operates at such an external temperature that it will not ignite a surrounding flammable atmosphere.

(49) *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."*)

(50) *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.)"]

(51) *Exposed.* (For the purposes of § 1910.308(e), *Communications systems.*) Where the circuit is in such a position that in case of failure of supports or insulation, contact with another circuit may result.

(52) *Externally operable.* Capable of being operated without exposing the operator to contact with live parts.

(53) *Feeder.* All circuit conductors between the service equipment, or the generator switchboard of an isolated plant, and the final branch-circuit overcurrent device.

(54) *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.

(55) *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.

(56) *Ground.* A conducting connection, whether intentional or accidental, between an electrical circuit or equipment and the earth, or to some conducting body that serves in place of the earth.

(57) *Grounded.* Connected to earth or to some conducting body that serves in place of the earth.

(58) *Grounded, effectively.* (Over 600 volts, nominal.) Permanently connected to earth through a ground connection of sufficiently low impedance and having sufficient ampacity that ground fault current which may occur cannot build up to voltages dangerous to personnel.

(59) *Grounded conductor.* A system or circuit conductor that is intentionally grounded.

(60) *Grounding conductor.* A conductor used to connect equipment or

the grounded circuit of a wiring system to a grounding electrode or electrodes.

(61) *Grounding conductor, equipment.* The conductor used to connect the non-current-carrying metal parts of equipment, raceways, and other enclosures to the system grounded conductor and/or the grounding electrode conductor at the service equipment or at the source of a separately derived system.

(62) *Grounding electrode conductor.* The conductor used to connect the grounding electrode to the equipment grounding conductor and/or to the grounded conductor of the circuit at the service equipment or at the source of a separately derived system.

(63) *Ground-fault circuit-interrupter.* A device whose function is to interrupt the electric circuit to the load when a fault current to ground exceeds some predetermined value that is less than that required to operate the overcurrent protective device of the supply circuit.

(64) *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.

(65) *Health care facilities.* 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.

(66) *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.

(67) *Hoistway.* Any shaftway, hatchway, well hole, or other vertical opening or space in which an elevator or dumbwaiter is designed to operate.

(68) *Identified.* Identified, as used in reference to a conductor or its terminal, means that such conductor or terminal can be readily recognized as grounded.

(69) *Induction heating.* Induction heating is the heating of a nominally conductive material due to its own I^2R losses when the material is placed in a varying electromagnetic field.

(70) *Insulated conductor.* See under "Conductor."

(71) *Interrupter switch.* (Over 600 volts, nominal.) A switch capable of making, carrying, and interrupting specified currents.

(72) *Irrigation machine.* An irrigation machine is 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.

(73) *Isolated.* Not readily accessible to persons unless special means for access are used.

(74) *Isolated power system.* A system comprising an isolating transformer or its equivalent, a line isolation monitor, and its ungrounded circuit conductors.

(75) *Labeled.* Equipment is "labeled" if there is attached to it a label, symbol, or other identifying mark of a nationally recognized testing laboratory which, (a) makes periodic inspections of the production of such equipment, and (b) whose labeling indicates compliance with nationally recognized standards or tests to determine safe use in a specified manner.

(76) *Lighting outlet.* An outlet intended for the direct connection of a lampholder, a lighting fixture, or a pendant cord terminating in a lampholder.

(77) *Listed.* Equipment is "listed" if it is of a kind mentioned in a list which, (a) is published by a nationally recognized laboratory which makes periodic inspection of the production of such equipment, and (b) states such equipment meets nationally recognized standards or has been tested and found safe for use in a specified manner.

(78) *Location.* (i) *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.

(ii) *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.

(iii) *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 exposed to weather and unprotected.

(79) *Medium voltage cable.* Type MV medium voltage cable is a single or multiconductor solid dielectric insulated cable rated 2000 volts or higher.

(80) *Metal-clad cable.* Type MC cable is a factory assembly of one or more conductors, each individually insulated and enclosed in a metallic sheath of interlocking tape, or a smooth or corrugated tube.

(81) *Mineral-insulated metal-sheathed cable.* 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 sheath.

(82) *Mobile X-ray.* X-ray equipment mounted on a permanent base with wheels and/or casters for moving while completely assembled.

(83) *Nonmetallic-sheathed cable.* Nonmetallic-sheathed cable is a factory assembly of two or more insulated conductors having an outer sheath of moisture resistant, flame-retardant, nonmetallic material. Nonmetallic sheathed cable is manufactured in the following types:

(i) *Type NM.* The overall covering has a flame-retardant and moisture-resistant finish.

(ii) *Type NMC.* The overall covering is flame-retardant, moisture-resistant, fungus-resistant, and corrosion-resistant.

(84) *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.

(85) *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.

(86) *Outlet.* A point on the wiring system at which current is taken to supply utilization equipment.

(87) *Outline lighting.* An arrangement of incandescent lamps or electric discharge tubing to outline or call attention to certain features such as the shape of a building or the decoration of a window.

(88) *Oven, wall-mounted.* An oven for cooking purposes designed for mounting in or on a wall or other surface and consisting of one of more heating elements, internal wiring, and built-in or separately mountable controls. (See *"Cooking unit, counter-mounted."*)

(89) *Overcurrent.* Any current in excess of the rated current of equipment or the ampacity of a conductor. It may result from overload (see definition), short circuit, or ground fault. A current in excess of rating may be accommodated by certain equipment and conductors for a given set of conditions. Hence the rules for overcurrent protection are specific for particular situations.

(90) *Overload.* Operation of equipment in excess of normal, full load rating, or of a conductor in excess of rated ampacity which, 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."*)

(91) *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."*)

(92) *Permanently installed decorative fountains and reflection pools.* Those that are constructed in the ground, on the ground, or in a building in such a manner that the pool cannot be readily disassembled for storage and are served by electrical circuits of any nature. These units are primarily constructed for their aesthetic value and not intended for swimming or wading.

(93) *Permanently installed swimming pools, wading and therapeutic pools.* Those that are constructed in the ground, on the ground, or in a building in such a manner that the pool cannot be readily disassembled for storage whether or not served by electrical circuits of any nature.

(94) *Portable X-ray.* X-ray equipment designed to be hand-carried.

(95) *Power and control tray cable.* Type TC power and control tray cable is 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.

(96) *Power fuse.* (Over 600 volts, nominal.) See *"Fuse."*

(97) *Power-limited tray cable.* Type PLTC nonmetallic-sheathed power limited tray cable is a factory assembly of two or more insulated conductors under a nonmetallic jacket.

(98) *Power outlet.* An enclosed assembly which may include receptacles, circuit breakers, fuseholders, fused switches, buses and watt-hour meter mounting means; intended to supply and control power to mobile homes, recreational vehicles or boats, or to serve as a means for distributing power required to operate mobile or temporarily installed equipment.

(99) *Premises wiring system.* That interior and exterior wiring, including power, lighting, control, and signal circuit wiring together with all of its associated hardware, fittings, and wiring devices, both permanently and temporarily installed, which extends from the load end of the service drop, or load end of the service lateral conductors to the outlet(s). Such wiring does not include wiring internal to appliances, fixtures, motors, controllers, motor control centers, and similar equipment.

(100) *Qualified person.* One familiar with the construction and operation of the equipment and the hazards involved.

(101) *Raceway.* A channel designed expressly for holding wires, cables, or busbars, with additional functions as permitted in this subpart. Raceways may be of metal or insulating material, and the term includes rigid metal conduit, rigid nonmetallic conduit, intermediate metal conduit, liquidtight flexible metal conduit, flexible metallic tubing, flexible metal conduit, electrical metallic tubing, underfloor raceways, cellular concrete floor raceways, cellular metal floor raceways, surface raceways, wireways, and busways.

(102) *Readily accessible.* Capable of being reached quickly for operation, renewal, or inspections, without requiring those to whom ready access is requisite to climb over or remove obstacles or to resort to portable ladders, chairs, etc. (*See "Accessible."*)

(103) *Receptacle.* A receptacle is a contact device installed at the outlet for the connection of a single attachment plug. A single receptacle is a single contact device with no other contact device on the same yoke. A multiple receptacle is a single device containing two or more receptacles.

(104) *Receptacle outlet.* An outlet where one or more receptacles are installed.

(105) *Remote-control circuit.* Any electric circuit that controls any other circuit through a relay or an equivalent device.

(106) *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.

(107) *Separately derived system.* A premises wiring system whose power is derived from generator, transformer, or converter winding and has no direct electrical connection, including a solidly connected grounded circuit conductor, to supply conductors originating in another system.

(108) *Service.* The conductors and equipment for delivering energy from the electricity supply system to the wiring system of the premises served.

(109) *Service cable.* Service conductors made up in the form of a cable.

(110) *Service conductors.* The supply conductors that extend from the street main or from transformers to the service equipment of the premises supplied.

(111) *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.

(112) *Service-entrance cable.* Service-entrance cable is a single conductor or multiconductor assembly provided with or without an overall covering, primarily used for services and of the following types:

(i) *Type SE,* having a flame-retardent, moisture-resistant covering, but not required to have inherent protection against mechanical abuse.

(ii) *Type USE,* recognized for underground use, having a moisture-resistant covering, but not required to have a flame-retardant covering or inherent protection against mechanical abuse. Single-conductor cables having an insulation specifically approved for the purpose do not require an outer covering.

(113) *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.

(114) *Service entrance conductors, underground system.* The service conductors between the terminals of the service equipment and the point of connection to the service lateral. Where service equipment is located outside the building walls, there may be no service-entrance conductors, or they may be entirely outside the building.

(115) *Service equipment.* The necessary equipment, usually consisting of a circuit breaker or switch and fuses, and their accessories, located near the point of entrance of supply conductors to a building or other structure, or an otherwise defined area, and intended to consititute the main control and means of cutoff of the supply.

(116) *Service raceway.* The raceway that encloses the service-entrance conductors.

(117) *Shielded nonmetallic-sheathed cable.* Type SNM, shielded nonmetallic-sheathed cable is 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.

(118) *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.

(119) *Sign.* See *"Electric Sign."*

(120) *Signaling circuit.* Any electric circuit that energizes signaling equipment.

(121) *Special permission.* The written consent of the authority having jurisdiction.

(122) *Storable swimming or wading pool.* A pool with a maximum dimension of 15 feet and a maximum wall height of 3 feet and is so constructed that it may be readily disassembled for storage and reassembled to its original integrity.

(123) *Switchboard.* A large single panel, frame, or assembly of panels which have switches, buses, instruments, overcurrent and other protective devices mounted on the face or back or both. Switchboards are generally accessible from the rear as well as from the front and are not intended to be installed in cabinets. (See *"Panelboard."*)

(124) *Switches.*

(i) *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.

(ii) *General-use snap switch.* A form of general-use switch so constructed that it can be installed in flush device boxes or on outlet box covers, or otherwise used in conjunction with wiring systems recognized by this subpart.

(iii) *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.

(iv) *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.

(125) *Switching devices.* (Over 600 volts, nominal.) Devices designed to close and/or 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.

(126) *Transportable X-ray.* X-ray equipment installed in a vehicle or that may readily be disassembled for transport in a vehicle.

(127) *Utilization equipment.* Utilization equipment means equipment which utilizes electric energy for mechanical, chemical, heating, lighting, or similar useful purpose.

(128) *Utilization system.* A utilization system is a system which provides electric power and light for employee workplaces, and includes the premises wiring system and utilization equipment.

(129) *Ventilated.* Provided with a means to permit circulation of air sufficient to remove an excess of heat, fumes, or vapors.

(130) *Volatile flammable liquid.* A flammable liquid having a flash point below 38 degrees C (100 degrees F) or whose temperature is above its flash point.

(131) *Voltage (of a circuit).* The greatest root-mean-square (effective) difference of potential between any two conductors of the circuit concerned.

(132) *Voltage, nominal.* A nominal value assigned to a circuit or system for the purpose of conveniently designating its voltage class (as 120/240, 480Y/277, 600, etc.). The actual voltage at which a circuit operates can vary from the nominal within a range that permits satisfactory operation of equipment.

(133) *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.

(134) *Watertight.* So constructed that moisture will not enter the enclosure.

(135) *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.

(136) *Wet location.* See "Location."

(137) *Wireways.* Wireways are 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.

(b) *Definitions applicable to §§ 1910.331 through 1910.360 [Reserved].*

(c) *Definitions applicable to §§ 1910.361 through 1910.380 [Reserved].*

(d) *Definitions applicable to §§ 1910.381 through 1910.398 [Reserved].*

Appendix A—Reference Documents

The following references provide information which can be helpful in understanding and complying with the requirements contained in Subpart S:

ANSI A17.1–71 Safety Code for Elevators, Dumbwaiters, Escalators and Moving Walks.
ANSI B9.1–71 Safety Code for Mechanical Refrigeration.
ANSI B30.2–76 Safety Code for Overhead and Gantry Cranes.
ANSI B30.3–75 Hammerhead Tower Cranes.
ANSI B30.4–73 Safety Code for Portal, Tower, and Pillar Cranes.
ANSI B30.5–68 Safety Code for Crawler, Locomotive, and Truck Cranes.
ANSI B30.6–77 Derricks.
ANSI B30.7–77 Base Mounted Drum Hoists.
ANSI B30.8–71 Safety Code for Floating Cranes and Floating Derricks.
ANSI B30.11–73 Monorail Systems and Underhung Cranes.
ANSI B30.12–75 Handling Loads Suspended from Rotocraft.
ANSI B30.13–77 Controlled Mechanical Storage Cranes.
ANSI B30.15–73 Safety Code for Mobile Hydraulic Cranes.
ANSI B30.16–73 Overhead Hoists.
ANSI C2–77 National Electrical Safety Code.
ANSI C33.27–74 Safety Standard for Outlet Boxes and Fittings for Use in Hazardous Locations, Class I, Groups A, B, C, and D, and Class II, Groups E, F, and G.
ANSI K61.1–72 Safety Requirements for the Storage and Handling of Anhydrous Ammonia.
ASTM D2155–66 Test Method for Autoignition Temperature of Liquid Petroleum Products.
ASTM D3176–74 Method for Ultimate Analysis of Coal and Coke.
ASTM D3180–74 Method for Calculating Coal and Coke Analyses from As Determined to Different Bases.
IEEE 463–77 Standard for Electrical Safety Practices in Electrolytic Cell Line Working Zones.
NFPA 20–76 Standard for the Installation of Centrifugal Fire Pumps.
NFPA 30–78 Flammable and Combustible Liquids Code.
NFPA 32–74 Standard for Drycleaning Plants.
NFPA 33–73 Standard for Spray Application Using Flammable and Combustible Materials.
NFPA 34–74 Standard for Dip Tanks Containing Flammable or Combustible Liquids.
NFPA 35–76 Standard for the Manufacture of Organic Coatings.
NFPA 36–74 Standard for Solvent Extraction Plants.
NFPA 40–74 Standard for the Storage and Handling of Cellulose Nitrate Motion Picture Film.
NFPA 56A–73 Standard for the Use of Inhalation Anesthetics (Flammable and Nonflammable).
NFPA 56F–74 Standard for Nonflammable Medical Gas Systems.
NFPA 58–76 Standard for the Storage and Handling of Liquefied Petroleum Gases.
NFPA 59–76 Standard for the Storage and Handling of Liquefied Petroleum Gases at Utility Gas Plants.
NFPA 70–78 National Electrical Code.
NFPA 70C–74 Hazardous Locations Classification.

NFPA 70E Standard for the Electrical Safety Requirements for Employee Workplaces.
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 Alarm Service.
NFPA 72C–75 Standard for the 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 77–72 Recommended Practice on Static Electricity.
NFPA 80–77 Standard for Fire Doors and Windows.
NFPA 86A–73 Standard for Ovens and Furnaces; Design, Location and Equipment.
NFPA 88A–73 Standard for Parking Structures.
NFPA 88B–73 Standard for Repair Garages.
NFPA 91–73 Standard for the Installation of Blower and Exhaust Systems for Dust, Stock, and Vapor Removal, or Conveying.
NFPA 101–78 Code for Safety to Life from Fire in Buildings and Structures. (Life Safety Code.)
NFPA 325M–69 Fire-Hazard Properties of Flammable Liquids, Gases, and Volatile Solids.
NFPA 493–75 Standard for Intrinsically Safe Apparatus for Use in Class I Hazardous Locations and Its Associated Apparatus.
NFPA 496–74 Standard for Purged and Pressurized Enclosures for Electrical Equipment in Hazardous Locations.
NFPA 497–75 Recommended Practice for Classification of Class I Hazardous Locations for Electrical Installations in Chemical Plants.
NFPA 505–75 Fire Safety Standard for Powered Industrial Trucks Including Type Designations and Areas of Use.
NMAB 353–1–79 Matrix of Combustion-Relevant Properties and Classification of Gases, Vapors, and Selected Solids.
NMAB 353–2–79 Test Equipment for Use in Determining Classifications of Combustible Dusts.
NMAB 353–3–80 Classification of Combustible Dusts in Accordance with the National Electrical Code.

Appendix B—Explanatory Data [Reserved]

Appendix C—Tables, Notes, and Charts [Reserved]

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