Report of the Committee on Electrical Safety Requirements for Employee Workplaces

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This list represents the membership at the time the Committee was balloted on the text of this edition. Since that time, changes in the membership may have occurred.

The Committee on Electrical Safety Requirements for Employee Workplaces presents for official adoption its report on a new document, NFPA 70E, *Standard on Electrical Safety Requirements for Employee Workplaces.*

This report has been submitted to letter ballot of the Committee, which consists of 18 voting members, of whom 17 have voted affirmatively and one member has not voted. (Mr. Cefalo did not return his ballot as he has retired.)

This report was submitted to the Correlating Committee for ballot and of nine principal voting members, nine voted affirmatively.

Standard for the Electrical Safety Requirements for Employee Workplaces

NFPA 70E–1979

FOREWORD TO NFPA 70E

The Standards Council of the National Fire Protection Association (NFPA) announced on January 7, 1976, the formal appointment of a new electrical standards development committee. Entitled the "Committee on Electrical Safety Requirements for Employee Workplaces, NFPA 70E," this new committee reports to the Association through the Electrical Correlating Committee of the National Electrical Code (NEC) Committee. This committee was formed to assist OSHA in preparing electrical safety standards which would serve OSHA's needs and which could be expeditiously promulgated through the provisions of Section 6(b) of the Occupational Safety and Health Act. OSHA found that in attempting to utilize the latest edition of NFPA 70, the *National Electrical Code (NEC),* it was confronted with the following problem areas:

A. Updating to a new edition of the *NEC* would have to be through the OSHA "6(b)" procedure. OSHA adopted the 1968 and then the 1971 *NEC* under Section 6(a) procedures of the Occupational Safety and Health Act of 1970. Today, however, OSHA can only adopt or modify a standard by the procedures of Section 6(b) of the OSHA Act, which provide for public notice, opportunity for public comment, and public hearings. The adoption of a new edition of the *NEC* by these procedures would require extensive effort and application of resources by OSHA and others. Even so, going through the "6(b)" procedures might result in requirements substantially different than those of the *NEC,* thereby creating the problem of conflict between the OSHA standard and other national and local standards.

B. The *NEC* is intended for use primarily by those who design, install, and inspect electrical installations. OSHA's electrical regulations address the employer and employee in their workplace. The technical content and complexity of the *NEC* is extremely difficult for the average employer and employee to understand.

C. Some of the detailed provisions within the *NEC* are not directly related to employee safety, and therefore are of little value for OSHA's needs.

D. Requirements for electrical safety related work practices and maintenance of the electrical system considered critical to safety are not found in the *NEC*, which is essentially an electrical installation document. However, OSHA must also consider and develop these safety areas in its regulations.

With these problem areas, it became apparent that a need existed for a new standard, tailored to fulfill OSHA's responsibilities, that would still be fully consistent with the *NEC*.

This led to the concept that a document be put together by a competent group, representing all interests, which would extract suitable portions from the *NEC* and from other safety standards applicable to electrical safety. These include NFPA 79, *Electrical Standard for Metalworking Machine Tools*; NFPA 70B, *Recommended Practice for Electrical Equipment Maintenance*; the *National Electrical Safety Code (ANSI)*; and others. This concept and an offer of assistance was submitted, in May 1975, to the Assistant Secretary of Labor for OSHA, who said, "The concept, procedures, and scope of the effort discussed with my staff for preparing the subject standard appear to have great merit, and an apparent need exists for this proposed consensus document which OSHA could consider for promulgation under the provisions of Section 6(b) of the Act. OSHA does have an interest in this effort and believes the proposed standard would serve a useful purpose." With this positive encouragement from OSHA, a proposal to prepare such a document was presented to the NFPA Electrical Section, which unanimously supported a recommendation that the NEC Correlating Committee examine the feasibility of developing a document to be used as a basis for evaluating electrical safety in the workplace. In keeping with the recommendation of the Electrical Section and Correlating Committee, the Standards Council authorized the establishment of a committee to carry out this examination.

The committee found it feasible to develop a standard for electrical installations that would be compatible with the OSHA requirements for safety for the employee in locations covered by the *NEC*. The new standard was visualized as consisting of four major

parts: Part I, Installation Safety Requirements; Part II, Safety Related Work Practices; Part III, Safety Related Maintenance Requirements; and Part IV, Safety Requirements for Special Equipment. Although desirable, it was not considered essential for all of the parts to be completed before the standard is published and made available. Each part is recognized as being an important aspect of electrical safety in the workplace, but the parts are sufficiently independent of each other to permit their separate publication. This new standard has been named NFPA 70E, *Electrical Safety Requirements for Employee Workplaces.*

Essential to the proper use of Part I of this standard is the understanding that it is not intended to be applied as a design, installation, modification, or construction standard for an electrical installation or system. Its content has been intentionally limited in comparison to the content of the *NEC* in order to apply to an electrical installation or system as part of an employee's workplace. This standard is compatible with corresponding provisions of the *NEC,* but is not intended to, nor can it, be used in lieu of the *NEC.*

It can be debated that all of the requirements of the *NEC,* when traced through a chain of events, may relate to an electrical hazard, but, for practical purposes, inclusion has not been made of those provisions which, in general, are not directly associated with employee safety. In determining what provisions should be included in Part I, the following guidelines were used:

A. Its provisions should give protection to the employee from electrical hazards.

B. Its provisions should be excerpted from the *NEC* in a manner that will maintain their intent as they apply to employee safety. In some cases it has been judged essential to the meaning of the excerpted passages to retain some material not applying to employee safety.

C. The provisions should be selected in a manner that will reduce the need for frequent revision, yet avoid technical obsolescence.

D. Compliance with the provisions should be determined by means of an inspection during the normal state of employee occupancy without removal of parts requiring shutdown of the electrical installation or by damaging the building structure 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 must the intent of the *NEC* be changed if the wording is changed.

Part I of NFPA 70E is therefore intended to serve a very specific need of OSHA and is in no way intended to be used as a substitute for the *NEC.* Omission of any requirements presently in the *NEC* does not in any way affect the *NEC,* nor should these omitted requirements be considered as unimportant. They are essential to the *NEC* and its intended application, *i.e.,* its use by those who design, install, and inspect electrical installations. NFPA 70E, on the other hand, is intended for use by employers, employees, and OSHA.

Editorial Note: Parts II, III, and IV and Appendix B of NFPA 70E are to be developed by the NFPA 70E Committee at a later date.

Standard for the Electrical Safety Requirements for Employee Workplaces

NFPA 70E–1979

Scope for NFPA 70E

A. This standard addresses those electrical safety requirements necessary to provide a practical and safe working area for employees in their pursuit of gainful employment. This standard covers:

(1) Electric conductors and equipment installed within or on buildings or other structures, including mobile homes and recreational vehicles; and other premises such as yards, carnival, parking, and other lots, and industrial substations.

(2) Conductors that connect the installations to a supply of electricity.

(3) Other outside conductors on the premises.

B. This standard does not cover:

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

(2) Installations underground in mines.

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

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

(5) Installations under the exclusive control of electric utilities for the purpose of communication or metering; or for the generation, control, transformation, transmission, and distribution of

electric energy 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.

C. This standard is divided into the following four parts and three appendices:

Part I	Installation Safety Requirements
Part II	Safety Related Work Practices
Part III	Safety Related Maintenance Requirements
Part IV	Safety Requirements for Special Equipment
Appendix A	Definitions
Appendix B	Tables, Charts, Notes
Appendix C	Reference Documents

Editorial Note: Parts II, III, and IV and Appendix B of NFPA 70E are to be developed by the NFPA 70E Committee at a later date.

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PART I
INSTALLATION SAFETY REQUIREMENTS

General

The requirements contained in Part I are based on the provisions of NFPA 70, the *National Electrical Code.* Where installations of electric conductors and equipment have been found to conform with the safety requirements of the *National Electrical Code* in use at the time of installation by governmental bodies or agencies having legal jurisdiction for enforcement of the *National Electrical Code,* this conformance shall be prima facie evidence that such installations were adequately designed and installed.

Part I of this standard is divided into five chapters. Chapters 1, 2, and 3 apply generally. Chapters 4 and 5 apply to hazardous (classified) locations and special systems. These latter chapters supplement or modify the general rules. Paragraph E of Chapter 5 covers communications systems and is independent of the other paragraphs and chapters except where specifically referenced.

NOTE: Appendices A, B, and C contain definitions, tables, charts, notes, and reference documents.

Chapter 1 General Requirements for Electrical Installations

A. Approval. The conductors and equipment required or permitted by this standard shall be acceptable only when approved.

NOTE: See definitions of "Approved," "Approved for the Purpose," "Labeled," and "Listed" in Appendix A.

B. Examination, Installation, and Use of Equipment.

(1) Examination. In judging equipment, considerations such as the following shall be evaluated:

(a) Suitability for installation and use in conformity with the provisions of this standard. Suitability of equipment may be evidenced by listing or labeling.

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

(c) Electrical insulation.

(d) Heating effects under normal conditions of use and also under abnormal conditions likely to arise in service.

(e) Arcing effects.

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

(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. 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 electric equipment. Other markings shall be provided giving voltage, current, wattage, and other ratings as may be required. The marking shall be of sufficient durability to withstand the environment involved.

F. Identification of Disconnecting Means. Each disconnecting means required by this standard for motors and appliances, and each service, feeder, or branch circuit at the point where it originates shall be legibly marked to indicate its purpose unless located and arranged so the purpose is evident. The marking shall be of sufficient durability to withstand the environment 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.

(a) Working Clearances. Except as elsewhere required or permitted in this standard, 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 shall not be less than indicated in Table 1-G(1) (a). In addition to the dimensions shown in Table 1-G(1) (a), workspace shall not be less than 30 in. wide in front of the electric equipment. Distances shall be measured from the live parts if such are exposed, or from the enclosure front or opening if such are enclosed. Concrete, brick, or tile walls shall be considered as grounded.

Working space shall not be 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.

By special permission smaller spaces may be permitted where it is judged that the particular arrangement of the installation will provide adequate accessibility.

Table 1-G(1) (a)
Working Clearances

Nominal Voltage to Ground	Minimum clear distance for condition (i)	(ii)	(iii)
	(ft)	(ft)	(ft)
0–150	3	3	3
151–600	3	3½	4

Where Conditions (i), (ii), and (iii) are as follows:

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

(ii) Exposed live parts on one side and grounded parts on the other side.

(iii) Exposed live parts on both sides of the workspace [not guarded as provided in Condition (i)] with the operator between.

(b) Clear Spaces. Working space required by this standard shall 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.

(c) 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.

(d) Front Working Space. In all cases where there are live parts normally exposed on the front of switchboards or motor control centers, the working space in front of such equipment shall not be less than 3 ft.

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

(f) Headroom. The minimum headroom of working spaces about service equipment, switchboards, panelboards, or motor control centers shall be 6¼ ft.

NOTE: As used in this standard, 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.

(a) Except as elsewhere required or permitted by this standard, live parts of electric equipment operating at 50 volts or more shall be guarded against accidental contact by approved cabinets or other forms of approved enclosures, or by any of the following means:

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

(ii) 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.

(iii) By location on a suitable balcony, gallery, or platform so elevated and arranged as to exclude unqualified persons.

(iv) By elevation of 8 ft or more above the floor or other working surface.

(b) 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.

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

H. Over 600 Volts, Nominal.

(1) General. Conductors and equipment used on circuits exceeding 600 volts, nominal, shall comply with all applicable provisions of the preceding requirements of this chapter and with the following provisions which supplement or modify the preceding requirements. In no case shall the provisions of Subparagraphs (2), (3), and (4) following apply to the equipment on the supply side of the service conductors.

(2) Enclosure for Electrical Installations. Electrical installations in a vault, room, or closet or in an area surrounded by a wall, screen, or fence, access to which is controlled by lock and key or other approved means, shall be considered to be accessible to qualified persons only. A wall, screen, or fence less than 8 ft in height shall not be considered as preventing access unless it has other features that provide a degree of isolation equivalent to an 8-ft 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.

(a) 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 Subparagraph H-3 of this chapter.

(b) 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 ft 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. When exposed to physical damage from vehicular traffic, suitable guards shall be provided.

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 shall not be less than 6½ ft high (measured vertically from the floor or platform), or less than 3 ft wide (measured parallel to the equipment). The depth shall be as required in Table 1-H(3) (a). In all cases, the workspace shall be adequate to permit at least a 90-degree opening of doors or hinged panels.

(a) 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 shall not be less than specified in Table 1-H(3) (a) unless otherwise specified in this standard. Distances shall be measured from the live parts if such are exposed or from the enclosure front or opening if such are enclosed.

Exception: Working space is not required in back of equipment such as dead-front 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 the energized parts on the back of enclosed equipment, a minimum working space of 30 in. horizontally shall be provided.

Table 1-H(3) (a)
Minimum Depth of Clear Working Space in Front of Electric Equipment

Nominal Voltage to Ground	Conditions (i)	(ii)	(iii)
	(ft)	(ft)	(ft)
601– 2,500	3	4	5
2,501– 9,000	4	5	6
9,001–25,000	5	6	9
25,001–75kV	6	8	10
Above 75kV	8	10	12

Where Conditions (i), (ii), and (iii) are as follows:

(i) 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 shall not be considered live parts.

(ii) Exposed live parts on one side and grounded parts on the other side. Concrete, brick, or tile walls will be considered as grounded surfaces.

(iii) Exposed live parts on both sides of the workspace [not guarded as provided in Condition (i)] with the operator between.

(b) 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.

(c) Elevation of Unguarded Live Parts. Unguarded live parts above working space shall be maintained at elevations not less than specified in Table 1-H(3) (c).

Table 1-H(3) (c)
Elevation of Unguarded Energized Parts Above Working Space

Nominal Voltage Between Phases	Minimum Elevation
601– 7,500	8 ft 6 in.
7,501–35,000	9 ft
Over 35kV	9 ft + 0.37 in. per kV above 35

(4) Entrance and Access to Workspace.

(a) At least one entrance not less than 24 in. wide and 6½ ft high shall be provided to give access to the working space about electric equipment. On switchboard and control panels exceeding 48 in. in width, there shall be one entrance at each end of such board where reasonably 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.

(b) 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.

Chapter 2* 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 other conductors.

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

B. Branch Circuits.

(1) **Ground-Fault Protection for Personnel on Construction Sites.** For installations under the jurisdiction of OSHA, see OSHA Regulations 29CFR 1926.400(H) and 1910.309(C).

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

C. Outside Branch Circuit, Feeder, and Service Conductors, 600 Volts, Nominal, or Less. Subparagraphs (1), (2), (3), and (4) following apply to branch circuit, feeder, and service conductors run outdoors as open conductors.

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

(a) Power conductors below communication conductors—30 in.

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

(c) Communication conductors below power conductors—same as power conductors.

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

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

(b) 12 ft—over areas subject to vehicular traffic other than truck traffic.

(c) 15 ft—over areas other than those specified in (d) following that are subject to truck traffic.

(d) 18 ft—over public streets, alleys, roads, and driveways.

(3) **Clearance from Building Openings.** Conductors shall have a clearance of at least 3 ft from windows, doors, porches, fire escapes, or similar locations. Conductors run above the top level of a window shall be considered out of reach from that window.

(4) **Clearance Over Roofs.** Except as provided in Subparagraphs (a) or (b) following, conductors shall have a clearance of not less than 8 ft from the highest point of roofs over which they pass.

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

(b) Where the voltage between conductors is 300 volts or less and the conductors do not pass over more than 4 ft 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 in.

(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.

(a) **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.

(b) Simultaneous Opening of Poles. Each disconnecting means shall simultaneously disconnect all ungrounded conductors.

(2) Services Over 600 Volts, Nominal.

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

(b) Warning Signs. Signs warning of high voltage shall be posted where unauthorized persons might come in contact with live parts.

E. Overcurrent Protection.

(1) 600 Volts, Nominal, or Less.

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

(b) Grounded Conductors. Except for motor running overload protection, overcurrent devices shall not interrupt the continuity of the grounded conductor unless all conductors of the circuit are opened simultaneously.

(c) 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 the overcurrent device.

(d) Arcing or Suddenly Moving Parts. Fuses and circuit breakers shall be so located or shielded that persons will not be burned or otherwise injured by their operation.

(e) Circuit Breakers. Circuit breakers shall clearly indicate whether they are in the open (off) or closed (on) position. 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.

Where used as switches in 120 volt, fluorescent lighting circuits, circuit breakers shall be approved for the purpose and marked "SWD."

(2) Overcurrent Protection, Over 600 Volts, Nominal. Feeders and branch circuits shall have short-circuit protection.

F. Grounding. Subparagraphs (1) through (7) following cover grounding requirements for systems, circuits, and equipment.

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

(a) All 3-wire DC systems shall have their neutral conductor grounded.

(b) All 2-wire DC systems operating at over 50 volts through 300 volts between conductors shall be grounded unless:

(i) They supply only industrial equipment in limited areas and are equipped with a ground detector; or

(ii) They are rectifier-derived from an AC system complying with (c), (d), and (e) following; or

(iii) They are fire-protective signaling circuits having a maximum current of 0.030 amperes.

(c) All AC circuits of less than 50 volts shall be grounded where they are installed as overhead conductors outside of buildings or where they are supplied by transformers and the transformer primary supply system is ungrounded or exceeds 150 volts to ground.

(d) AC systems of 50 volts to 1000 volts that are not covered in Subparagraph (e) following shall be grounded under any of the following conditions:

(i) Where the system can be so grounded that the maximum voltage to ground on the ungrounded conductors does not exceed 150 volts.

(ii) Where the system is nominally rated 480Y/277 volt, 3-phase, 4-wire in which the neutral is used as a circuit conductor.

(iii) Where 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.

(iv) Where a service conductor is uninsulated.

(e) AC systems of 50 volts to 1000 volts are not required to be grounded under any of the following conditions:

(i) Where the system is used exclusively to supply industrial electric furnaces for melting, refining, tempering, and the like.

(ii) Where the system is separately derived and is used exclusively for rectifiers supplying only adjustable speed industrial drives.

(iii) Where 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:

(a) The system is used exclusively for control circuits,

(b) The conditions of maintenance and supervision assure that only qualified persons will service the installation,

(c) Continuity of control power is required,

(d) Ground detectors are installed on the control system.

(iv) Where 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.

(a) 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.

(b) 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.

(c) On extensions of existing branch circuits which do not have an equipment grounding conductor, grounding-type receptacles shall be permitted to 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, continuous, and effective.

(5) Supports, Enclosures, and Equipment to Be Grounded.

(a) Supports and Enclosures for Conductors. Except as provided in (i) and (ii) following, metal cable trays, metal raceways, and metal enclosures for conductors shall be grounded.

(i) Metal enclosures such as sleeves and similar enclosures that are used to protect cable assemblies from physical damage need not be grounded.

(ii) Metal enclosures for conductors added to existing installations of open wire, knob-and-tube wiring, and nonmetallic-sheathed cable, if in runs of less than 25 ft, if free from probable contact with ground, grounded metal, metal laths, or other conductive materials, and if guarded against contact by persons, shall not be required to be grounded.

(b) Service Equipment Enclosures. Metal enclosures for service equipment shall be grounded.

(c) 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.

(d) Fixed Equipment. Exposed non-current-carrying metal parts of fixed equipment likely to become energized shall be grounded under any of the conditions specified in (i) through (vi) following:

(i) Where within 8 ft vertically or 5 ft horizontally of ground or grounded metal objects and subject to contact by persons.

(ii) Where located in a wet or damp location and not isolated.

(iii) Where in electrical contact with metal.

(iv) Where in a hazardous (classified) location.

(v) Where supplied by a metal-clad, metal-sheathed, or grounded metal raceway wiring method.

(vi) Where equipment operates with any terminal at over 150 volts to ground; except the following need not be grounded:

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

(b) Metal frames of electrically heated devices which are permanently and effectively insulated from ground; and

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

(e) Equipment Connected by Cord and Plug. Under any of the conditions described in (i) through (iii) following, exposed non-current-carrying metal parts of cord- and plug-connected equipment likely to become energized shall be grounded.

(i) In hazardous (classified) locations *(see Chapter 4)*.

(ii) Where operated at over 150 volts to ground, except guarded motors and metal frames of electrically heated appliances where the appliance frames are permanently and effectively insulated from ground.

(iii) In other than residential occupancies:

(a) Refrigerators, freezers, and air conditioners;

(b) Clothes-washing, clothes-drying, dishwashing machines, sump pumps, and electrical aquarium equipment;

(c) Hand-held motor operated tools;

(d) Motor operated appliances of the following types: hedge clippers, lawn mowers, snow blowers, and wet scrubbers;

(e) Cord- and plug-connected appliances used in damp or wet locations or by persons standing on the ground or on metal floors or working inside of metal tanks or boilers;

(f) Portable and mobile X-ray and associated equipment;

(g) Tools likely to be used in wet and conductive locations; and

(h) Portable hand lamps.

Tools likely to be used in wet and conductive locations shall not be required to be grounded where supplied through an isolating transformer with an ungrounded secondary of not over 50 volts.

Listed portable tools and appliances protected by an approved system of double insulation, or its equivalent, shall not be required to be grounded. Where 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.

(f) Nonelectrical Equipment. The metal parts of the following nonelectrical equipment shall be grounded: Frames and track 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 Equipment. Non-current-carrying metal parts of fixed equipment, if required to be grounded, 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 shall be permitted to be run separately from the circuit conductors.

Electric equipment secured to, and in electrical contact with, a grounded metal rack or structure provided for its support shall be considered to be effectively grounded. The structural metal frame of a building shall not be used as the required equipment grounding conductor for AC equipment. Metal car frames supported by metal hoisting cables attached to or running over metal sheaves or drums of grounded elevator machines shall also be considered to be effectively grounded.

(7) Grounding of Systems and Circuits of 1000 Volts and Over (High Voltage).

(a) General. Where high voltage systems are grounded, they shall comply with all applicable provisions of the preceding subparagraphs of Chapter 2, Section F, and with the following subparagraphs which supplement and modify the preceding subparagraphs.

(b) Grounding of Systems Supplying Portable Equipment. Systems supplying portable high voltage equipment, other than substations installed on a temporary basis, shall comply with (i) through (iv) following:

(i) Portable high voltage equipment shall be supplied from a system having its neutral grounded through an impedance. Where a delta-connected high voltage system is used to supply portable equipment, a system neutral shall be derived.

(ii) Exposed non-current-carrying metal parts of portable equipment shall be connected by an equipment grounding conductor to the point at which the system neutral impedance is grounded.

(iii) 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.

(iv) The grounding electrode to which the portable equipment system neutral impedance is connected shall be isolated from and separated in the ground by at least 20 ft from any other system or equipment grounding electrode, and there shall be no direct connection between the grounding electrodes, such as buried pipe, fence, etc.

(c) 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, except that equipment which is guarded by location and isolated from ground need not be grounded. Additionally, pole-mounted distribution apparatus at a height exceeding 8 ft above ground or grade level need not be grounded.

Chapter 3 Wiring Methods, Components, and Equipment

A. Wiring Methods. The provisions of this chapter do not apply to the conductors that are an integral part of factory-assembled equipment.

(1) General Requirements.

(a) Electrical Continuity of Metal Raceways and Enclosures. Metal raceways, cable armor, and other 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.

(b) 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 shall be installed in any duct, or shaft containing only such ducts, used for vapor removal or for ventilation of commercial-type cooking equipment.

(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 the following subparagraphs, all other requirements of this standard for permanent wiring shall apply to temporary wiring installations.

(a) Uses Permitted, 600 Volts, Nominal, or Less. Temporary electrical power and lighting installations shall be permitted during the period of construction, remodeling, maintenance, repair, or demolition of buildings, structures, equipment, or similar activities; and for a period not to exceed 90 days for Christmas decorative lighting, carnivals, and similar purposes; and for experimental or developmental work.

(b) Uses Permitted, Over 600 Volts, Nominal. Temporary wiring shall be permitted during periods of construction, tests, experiments, or emergencies.

(c) General.

(i) *Feeders.* Feeders shall originate in an approved distribution center. The conductors shall be permitted within multiconductor cord or cable assemblies, or, where not subject to physical damage, they shall be permitted to be run as open conductors on insulators not more than 10 ft apart.

(ii) *Branch Circuits.* All branch circuits shall originate in an approved power outlet or panelboard. Conductors shall be permitted within multiconductor cord or cable assemblies or as open conductors. When run as open conductors they shall be fastened at ceiling height every 10 ft. No branch-circuit conductor shall be laid on the floor. Each branch circuit that supplies receptacles or fixed equipment shall contain a separate equipment grounding conductor when run as open conductors.

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

(iv) *Earth Returns.* No bare conductors nor earth returns shall be used for the wiring of any temporary circuit.

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

(vi) *Lamp Protection.* All lamps for general illumination shall be protected from accidental contact or breakage. Protection shall be provided by elevation of at least 7 ft from normal working surface or by a suitable fixture or lampholder with a guard.

(vii) *Splices.* On construction sites a box shall not be required for splices or junction connections where the circuit conductors are multiconductor cord or cable assemblies or open conductors. A box shall be used wherever a change is made to a raceway system or a cable system which is metal clad or metal sheathed.

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

(3) Cable Trays.

(a) Uses Permitted.

(i) The following shall be permitted to be installed in cable tray systems:

(a) Mineral-insulated metal-sheathed cable (Type MI);

(b) Armored cable (Type AC);

(c) Metal-clad cable (Type MC);

(d) Power-limited tray cable (Type PLTC);

(e) Nonmetallic-sheathed cable (Type NM or NMC);

(f) Shielded nonmetallic-sheathed cable (Type SNM);

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

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

(i) Power and control tray cable (Type TC);

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

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

(ii) In industrial establishments only, where conditions of maintenance and supervision assure that only qualified persons will service the installed cable tray system, any of the cables in Subparagraphs (a) and (b) following shall be permitted to be installed in ladder, ventilated trough, or 4-in. ventilated channel-type cable trays:

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

(b) *Multiconductor.* Type MV cables, where exposed to direct rays of the sun, shall be sunlight-resistant. Cable trays in hazardous (classified) locations shall contain only the cable types permitted in such locations.

(b) Uses Not Permitted. Cable tray systems shall not be used in hoistways or where subjected to severe physical damage.

(4) Open Wiring on Insulators.

(a) Uses Permitted. Open wiring on insulators shall be permitted on systems of 600 volts, nominal, or less for industrial or agricultural establishments, indoors or outdoors, in wet or dry locations, where subject to corrosive vapors, and for services.

(b) Conductor Supports. Conductors shall be rigidly supported on noncombustible, nonabsorbent insulating materials and shall not contact any other objects.

(c) Flexible Nonmetallic Tubing. In dry locations where not exposed to severe physical damage, conductors shall be permitted to be separately enclosed in flexible nonmetallic tubing. The tubing shall be in continuous lengths not exceeding 15 ft and secured to the surface by straps at intervals not exceeding 4½ ft.

(d) 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. Where 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.

(e) Protection from Physical Damage. Conductors within 7 ft from the floor shall be considered exposed to physical damage. When open conductors cross ceiling joists 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 adequately closed. Unused openings in cabinets, boxes, and fittings shall be effectively closed.

(2) Covers and Canopies. All pull boxes, junction boxes, and fittings shall be provided with covers approved for the purpose. Where 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 standard for pull and junction boxes, the following shall apply:

(a) Boxes shall provide a complete enclosure for the contained conductors or cables.

(b) Boxes shall be closed by suitable covers securely fastened in place. Underground box covers that weigh over 100 lbs shall be considered as meeting 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 shall be permitted to be mounted so that the throw will be either vertical or horizontal. Where 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, except panelboards other than the dead-front externally-operable type shall be 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, and panelboard enclosures in damp or wet locations shall be installed so as to prevent moisture or water from entering and accumulating within the enclosure. In wet locations the enclosure shall be weatherproof.

(2) Switches, circuit breakers, and switchboards installed in a wet location shall be enclosed in a weatherproof enclosure.

F. Conductors for General Wiring. All conductors used for general wiring shall be insulated unless specifically permitted to be otherwise. 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, 600 Volts, Nominal, or Less.

(1) Use of Flexible Cords and Cables.

(a) Flexible cords and cables shall be approved and suitable for conditions of use and location. Flexible cords and cables shall be used only for:

(i) Pendants;

(ii) Wiring of fixtures;

(iii) Connection of portable lamps or appliances;

(iv) Elevator cables;

(v) Wiring of cranes and hoists;

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

(vii) Prevention of the transmission of noise or vibration;

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

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

(b) Unless specifically permitted in Subparagraph (a) above, flexible cords and cables shall not be used:

(i) As a substitute for the fixed wiring of a structure;

(ii) Where run through holes in walls, ceilings, or floors;

(iii) Where run through doorways, windows, or similar openings;

(iv) Where attached to building surfaces; or

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

(c) Flexible cords used in 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. 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. Flexible cords shall be used only in continuous lengths without splice or tap when initially installed. The repair of hard usage and extra hard usage flexible cords No. 12 or larger shall be permitted if spliced so that the splice retains the insulation, outer sheath properties, and usage characteristics of the cord being spliced. 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 2000 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 shall 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 a type 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 shall be permitted:

(a) For installation in lighting fixtures and in similar equipment where enclosed or protected and not subject to bending or twisting in use; or

(b) For connecting lighting fixtures to the branch-circuit conductors supplying the fixtures.

(3) Uses Not Permitted. Fixture wires shall 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.

(a) Fixtures, lampholders, lamps, rosettes, and receptacles shall have no live parts normally exposed to contact except rosettes and cleat-type lampholders and receptacles located at least 8 ft above the floor shall be permitted to have exposed parts.

(b) 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.

(c) 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.

(d) 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).

(a) Receptacles, cord connectors, and attachment plugs shall be constructed so that the receptacle or cord connectors will not accept an attachment plug with a different voltage or current rating than that for which the device is intended, except a 20-ampere T-slot receptacle or cord connector shall be permitted to accept a 15-ampere attachment plug of the same voltage rating.

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

(3) Appliances.

(a) Appliances, other than those in which the current-carrying parts at high temperatures are necessarily exposed, shall have no live parts normally exposed to contact.

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

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

(4) Motors.

(a) In Sight From. Where specified that one equipment shall be "in sight from" another equipment, one shall be visible and not more than 50 ft from the other.

(b) Disconnecting Means.

(i) A disconnecting means shall be located in sight from the controller location. However, a single disconnecting means shall be permitted to 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 circuits over 600 volts, nominal, shall be permitted to 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 to be locked in the open position.

(ii). 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.

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

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

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

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

(v) One of the disconnecting means shall be readily accessible.

(vi) An individual disconnecting means shall be provided for each motor, but a single disconnecting means may be used for a group of motors under any one of the following conditions:

(a) Where a number of motors drive special parts of a single machine or piece of apparatus, such as metal and woodworking machines, cranes, and hoists.

(b) Where a group of motors is under the protection of one set of branch-circuit protective devices.

(c) Where a group of motors is in a single room within sight from the location of the disconnecting means.

(c) 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 a process and motor overload sensing devices are connected to a supervised alarm.

(d) Protection of Live Parts—All Voltages.

(i) 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 be guarded.

Exposed live parts of motors and controllers operating at 50 volts or more between terminals shall be guarded against accidental contact by one of the following:

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

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

(c) By elevation 8 ft or more above the floor.

(ii) 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.

(a) The following subparagraphs cover the installation of all transformers except the following:

(i) Current transformers;

(ii) Dry-type transformers installed as a component part of other apparatus;

(iii) Transformers which are an integral part of an X-ray, high-frequency, or electrostatic-coating apparatus;

(iv) Transformers used with Class 2 and Class 3 circuits, sign and outline lighting, electric discharge lighting, and power-limited fire-protective signaling circuits; and

(v) Liquid-filled or dry-type transformers used for research, development, or testing, where effective safeguard arrangements are provided.

(b) The operating voltage of exposed live parts of transformer installations shall be indicated by warning signs or visible markings on the equipment or structure.

(c) Dry-type, high fire point liquid-insulated, and askarel-insulated transformers installed indoors and rated over 35kV shall be in a vault.

(d) If they present a fire hazard to employees, oil-insulated transformers installed indoors shall be in a vault.

(e) Combustible material, combustible buildings and parts of buildings, fire escapes, and door and window openings shall be safeguarded from fires originating in oil-insulated transformers attached to or adjacent to a building or combustible material.

(f) 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 or quickly opened from the inside.

(g) Any pipe or duct system foreign to the vault installation shall not enter or pass through a transformer vault.

(h) Materials shall not be stored in transformer vaults.

(6) Capacitors.

(a) 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.

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

(i) 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.

(ii) For series capacitors, the proper switching shall be assured by use of one of the following:

(a) Mechanically sequenced isolating and bypass switches,

(b) Interlocks, or

(c) Switching procedure prominently displayed at the switching location.

(7) Storage Batteries. Provisions shall be made for sufficient diffusion and ventilation of gases from the battery to prevent the accumulation of an explosive mixture.

K. Specific Purpose Equipment and Installations.

(1) Electric Signs and Outline Lighting.

(a) Disconnecting Means. Signs operated by electronic or electromechanical controllers located external to 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 shall open all ungrounded conductors and shall be within the sight of the sign or outline lighting it controls.

(b) Doors or covers giving access to uninsulated parts of indoor signs or outline lighting exceeding 600 volts and accessible to other than qualified employees shall either be provided with interlock switches to disconnect the primary circuit, or shall be so fastened that the use of other than ordinary tools will be necessary to open them.

(2) Cranes and Hoists.

(a) Disconnecting Means.

(i) A disconnecting means shall be provided between the runway contact conductors and the power supply.

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

(b) Control. A limit switch or other device shall be provided to prevent the load block from passing the safe upper limit of travel of all hoisting mechanisms.

(3) Elevators, Dumbwaiters, Escalators, and Moving Walks.

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

Where interconnections between control panels are necessary for operation of the system or multicar installations that remain 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."

(b) Control Panels. Where 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.

(4) Electric Welders—Disconnecting Means.

(a) A disconnecting means shall be provided in the supply 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 integral part of the welder.

(b) 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 shall not be less than the supply conductor ampacity.

(5) Data Processing Systems—Disconnecting Means.

(a) In data processing rooms, a disconnecting means shall be provided to disconnect the ventilation system serving that room and the power to all electric equipment in the room except lighting. It shall be controlled from locations readily accessible to the operator and at designated exit doors for the data processing room.

(b) In general building areas, a disconnecting means shall be provided to disconnect all interconnected data processing equipment in the area. It shall be controlled from a location readily accessible to the operator.

(6) X-Ray Equipment for Nonmedical and Nondental Use.

(a) 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) Where 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 persons with its live parts.

(b) Control.

(i) *Radiographic and Fluoroscopic Types.* All 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.

(7) Induction and Dielectric Heating Equipment.

(a) Scope. Subparagraphs (b) and (c) following cover induction and dielectric heating equipment and accessories for industrial and scientific applications, but not for medical or dental applications or for appliances.

(b) 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 of noncombustible material.

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

(iii) *Access to Internal Equipment.* Where doors are used giving access to voltages from 500 to 1000 volts AC or DC, either door locks or interlocks shall be provided. Where doors are used giving access to voltages of over 1000 volts AC or DC, either mechanical lockouts with a disconnecting means to prevent access until 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 may be protected by insulation and/or refractory materials. Interlock switches shall be used on all hinged access doors, sliding panels, or other easy means of access to the applicator. All 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 shall not be 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 heating equipment can be isolated from its supply circuit.

(c) Remote Control. Where 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.

(8) Electrolytic Cells.

(a) Scope. These provisions for electrolytic cells apply to the installation of the electrical components and accessory equipment of electrolytic cells, electrolytic cell lines, and process power supply for the production of aluminum, cadmium, chlorine, copper, fluorine, hydrogen peroxide, magnesium, sodium, sodium chlorate, and zinc.

Not covered by these provisions are cells used as a source of electric energy and for electroplating processes and cells used for the production of hydrogen.

(b) Definitions Applicable to this Paragraph.

(i) Cell, Electrolytic: A receptacle or vessel in which electro-chemical reactions are caused by applying energy for the purpose of refining or producing usable materials.

(ii) Cell Line: An assembly of electrically interconnected electrolytic cells supplied by a source of direct-current power.

(iii) 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 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.

(iv) 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.

(c) Disconnecting Means.

(i) Where 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 shall be permitted to be used as the disconnecting means.

(d) Portable Electric Equipment.

(i) The frames and enclosures of portable electric equipment used within the cell line working zone shall not be grounded. However, these frames and enclosures shall be permitted to be grounded where the cell line circuit voltage does not exceed 200 volts DC or where guarded.

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

(e) Power Supply Circuits and Receptacles for Portable Electric Equipment.

(i) Circuits supplying power to ungrounded receptacles for hand-held cord-connected equipments 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 shall 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 be a distinctive configuration, distinctively marked, and shall not be used in any other location in the plant.

(f) Fixed and Portable Electric Equipment.

(i) AC systems supplying fixed and portable electric equipment within the cell line working zone shall not be required to be grounded.

(ii) Exposed conductive surfaces, such as electric equipment housings, cabinets, boxes, motors, raceways and the like that are within the cell line working zone shall not be required to 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) Bonding of fixed electric equipment to the energized conductive surfaces of the cell line, its attachments, or auxiliaries shall be permitted. Where fixed electric equipment is mounted on an energized conductive surface it shall be bonded to that surface.

(g) Auxiliary Nonelectric Connections. Auxiliary nonelectric connections, such as air hoses, water hoses, and the like, to an electrolytic cell, its attachments, or auxiliary equipments shall not have continuous conductive reinforcing wire, armor, braids, and the like. Hoses shall be of a nonconductive material.

(h) Cranes and Hoists.

(i) 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.

(9) Electrically Driven or Controlled Irrigation Machines.

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

(b) Disconnecting Means for Center Pivot Irrigation Machines. The main disconnecting means for the 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.

(10) Swimming Pools, Fountains, and Similar Installations.

(a) Scope. Subparagraphs (b) through (d) following 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.

(b) 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 shall be permitted to be located not less than 5 ft from the inside walls of a pool. All other

receptacles on the property shall be located at least 10 ft from the inside walls of a pool. All receptacles shall be protected by ground-fault circuit-interrupters if they are located within 15 ft of the inside walls of the pool.

NOTE: In determining the above dimensions, the distance to be measured is the shortest path the supply cord of an appliance connected to the receptacles would follow without piercing a floor, wall, or ceiling of a building or other effective permanent barrier.

(ii) *Lighting Fixtures and Lighting Outlets.*

(a) Lighting fixtures and lighting outlets shall not be installed over a pool or over the area extending 5 ft horizontally from the inside walls of a pool unless 12 ft above the maximum water level. However, existing lighting fixtures and lighting outlets located less than 5 ft measured horizontally from the inside walls of a pool shall be at least 5 ft above the surface of the maximum water level and shall be rigidly attached to the existing structure. They shall also be protected by a ground-fault circuit-interrupter installed in the branch circuit supplying the fixture.

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

(c) Lighting fixtures other than underwater fixtures that are within 16 ft, measured radially, of any point on the water surface and fixed or stationary equipment rated at 20 amperes or less shall be permitted to be connected with a flexible cord. For other than storable pools, the flexible cord shall not exceed 3 ft in length and shall have a copper equipment grounding conductor not smaller than No. 12 with a grounding-type attachment plug.

(c) 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 shall be installed for operation at over 150 volts between conductors.

(d) 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.

Chapter 4 Hazardous (Classified) Locations

A. Scope. This chapter 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 hangers, 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 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 Appendix A. All other applicable requirements in this standard shall apply unless modified by provisions of this chapter.

B. General.

(1) Approval. 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.

(2) Intrinsically Safe Equipment. Equipment and associated wiring approved as intrinsically safe shall be permitted in any hazardous (classified) location for which it is approved.

(3) Conduits. All conduits shall be threaded and shall be made wrenchtight. Where it is impractical to make a threaded joint tight, a bonding jumper shall be utilized.

(4) Marking. Approved equipment not covered in (a), (b), or (c) following 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.

(a) Equipment of the non-heat-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.

(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, other than fixed lighting fixtures, which is acceptable for use in Division 2 locations shall not be required to be marked with the class, group, division, or operating temperature.

(5) Equipment in Division 2 Locations. Equipment that has been approved for a Division 1 location shall be permitted in a Division 2 location of the same class and group.

General-purpose equipment or equipment in general-purpose enclosures shall be permitted to be installed in Division 2 locations if the equipment does not constitute a source of ignition under normal operating conditions.

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.

Chapter 5 of NFPA 70, the *National Electrical Code,* which is referenced in Appendix C, contains guidelines that are appropriate for determining the type and design of equipment and installations with respect to **C(3)** above. The guidelines in this referenced 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.

Chapter 5 Special Systems

A. Systems Over 600 Volts, Nominal. Subparagraphs (1), (2), (3), and (4) following cover the general requirements for all circuits and equipment operated at over 600 volts.

(1) Wiring Methods for Fixed Installations. Aboveground 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. Conductors emerging from the ground shall be enclosed in approved raceways. Open runs of nonmetallic-sheathed cable or of bare conductors or busbars shall be permitted in locations accessible only to qualified persons. Metallic shielding components for conductors such as tapes, wires, or braids 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.

(2) Interrupting and Isolating Devices.

(a) 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 shall be permitted. A means of indicating the open and closed positions of circuit breakers shall be provided.

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

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

(3) Mobile and Portable Equipment.

(a) 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 and qualified persons may open it and shall be marked with a sign warning of the presence of energized parts.

(b) 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 opening locked doors. Enclosures and metal cabinets shall be locked so that only authorized and qualified persons may 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.

(a) Conductors. Conductors in tunnels shall be installed in one or more of the following:

(i) Metal conduit or other metal raceway,

(ii) Type MC cable, or

(iii) Other approved multiconductor cable.

Conductors shall also be so located or guarded so as to protect them from physical damage. Multiconductor portable cable shall be permitted to 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 shall be permitted to be insulated or bare.

(b) 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.

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

(d) 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 ft throughout the tunnel.

B. Emergency Power Systems.

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

(2) Wiring Methods. Emergency circuit wiring shall be kept entirely independent of all other wiring and equipment and shall not enter the same raceway, cable, box, or cabinet with other wiring except 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 required, 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 (a), (b), and (c) following:

(a) Class 1 Circuits.

(i) 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.

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

(b) Class 2 and Class 3 Circuits.

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

(ii) 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.

(iii) 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.

(c) The maximum circuit voltages in (a) and (b) above apply to sinusoidal AC or continuous DC power sources, and where wet contact occurrence 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.

D. Fire Protective Signaling Systems.

(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:

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

(b) 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 shall be permitted to 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 shall be permitted in the same enclosure, cable, or raceway only when 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 in. from conductors of any light, power, Class 1, and non-power-limited fire protective signaling circuits unless a special method of conductor separation is employed. Cables and conductors of two or more power-limited fire protective signaling circuits or Class 3 circuits shall be permitted in the same cable, enclosure, or raceway. Conductors of one or more Class 2 circuits shall be 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 rated for maximum voltage of any conductor or cable with this raceway or enclosure.

(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.

(2) Protective Devices.

(a) 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.

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

(3) Conductor Location.

(a) Outside of Buildings.

(i) 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.

(ii) The clearance between lead-in conductors and any lightning protection conductors shall not be less than 6 ft.

(b) On Poles. Where practicable, communication conductors on poles shall be located below the light or power conductors and shall not be attached to a crossarm that carries light or power conductors.

(c) 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 in. from conductors of any light or power or Class 1 circuits unless a special 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 well away from overhead conductors of electric light and power circuits of over 150 volts to ground so as to avoid the possibility of the antenna or structure falling into or making accidental contact with such circuits.

(5) Grounding.

(a) Lead-in Conductors. Where 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.

(b) Antenna Structures. Masts and metal structures supporting antennas shall be permanently and effectively grounded without splice or connection in the grounding conductor.

(c) Equipment Enclosures. Transmitters shall be enclosed in a metal frame or grill or separated from the operating space by a barrier or other equivalent means, 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 whose metallic shield is effectively grounded.

PART II
SAFETY-RELATED WORK PRACTICES
[*RESERVED*]

PART III
SAFETY-RELATED MAINTENANCE REQUIREMENTS
[*RESERVED*]

PART IV
SAFETY REQUIREMENTS FOR SPECIAL EQUIPMENT
[RESERVED]

Appendix A Definitions

Part A of Appendix A contains definitions to apply wherever the terms are used throughout this standard. Part B contains definitions applicable only to the provisions that specifically cover installations and equipment operating at over 600 volts, nominal.

A. General.

Accessible. (As applied to wiring methods.) Capable of being removed or exposed without damaging the building structure or finish, or not permanently closed in by the structure or finish of the building. *(See "Concealed" and "Exposed.")*

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

Ampacity. Current-carrying capacity of electric conductors expressed in amperes.

Appliance. 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.

Approved. Acceptable to the authority having jurisdiction.

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.")*

Armored Cable. Type AC armored cable is a fabricated assembly of insulated conductors in a flexible metallic enclosure.

Askarel. A generic term for a group of nonflammable synthetic chlorinated hydrocarbons used as electrical insulating media. Askarels of various compositional types are used. Under arcing conditions the gases produced, while consisting predominantly of noncombustible hydrogen chloride, can include varying amounts of combustible gases depending upon the askarel type.

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

Automatic. Self-acting, operating by its own mechanism when actuated by some impersonal influence, as, for example, a change in current strength, pressure, temperature, or mechanical configuration.

Bare Conductor. See under "Conductor."

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.

Bonding Jumper. A reliable conductor to assure the required electrical conductivity between metal parts required to be electrically connected.

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

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.

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.

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.

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

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.

Circuit Breaker. A device designed to open and close a circuit by nonautomatic means and to open the circuit automatically on a predetermined overcurrent without injury to itself when properly applied within its rating.

Class I Locations. Class I locations are those in which flammable gases or vapors are or may be present in the air in quantities sufficient to produce explosive or ignitible mixtures. Class I locations include those specified in (a) and (b) following:

(a) Class I, Division 1. A Class I, Division 1 location is a location: (1) in which hazardous concentrations of flammable gases or vapors exist continuously, intermittently, or periodically under normal operating conditions; or (2) in which hazardous concentrations of such gases or vapors may exist frequently because of repair or maintenance operations or because of leakage; or (3) 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 hazardous 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 hazardous concentrations of flammable vapors or gases are likely to occur in the course of normal operations.

(b) Class I, Division 2. A Class I, Division 2 location is a location: (1) 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 (2) in which hazardous concentrations of gases or vapors are normally prevented by positive mechanical ventilation, and which might become hazardous through failure or abnormal operation of the ventilating equip-

ment; or (3) 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, in the judgment of the authority having jurisdiction, would become hazardous only in case of an accident or of some unusual operating condition. The quantity of hazardous material that might escape in case of accident, the adequacy of ventilating equipment, the total area involved, and the record of the industry or business with respect to explosions or fires are all factors that merit consideration in determining the classification and extent of each location.

Piping without valves, checks, meters, and similar devices would not ordinarily introduce a hazardous condition even though used for hazardous liquids or gases. Locations used for the storage of hazardous liquids or of liquefied or compressed gases in sealed containers would not normally be considered hazardous unless subject to other hazardous conditions also.

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.

Class II Locations. Class II locations are those that are hazardous because of the presence of combustible dust. Class II locations include those specified in (a) and (b) following:

(a) Class II, Division 1. A Class II, Division 1 location is a location: (1) in which combustible 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.

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 dusts 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.

(b) Class II, Division 2. 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: (1) 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 (2) 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.

NOTE: 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, would include rooms and areas containing only closed spouting and conveyors, closed bins or hoppers, or machines and equipment from which appreciable quantities of dust would escape only under abnormal operating conditions; rooms or areas adjacent to a Class II, Division 1 location as described in (a) above, and into which explosive or ignitible concentrations of suspended dust might be communicated only under abnormal operating conditions; rooms or areas where the formation of explosive or ignitible concentrations of suspended dust is prevented by the operation of effective dust control equipment; warehouses and shipping rooms where dust-producing materials are stored or handled only in bags or containers; and other similar locations.

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 those specified in (a) and (b) following:

(a) 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.

(b) Class III, Division 2. A Class III, Division 2 location is a location in which easily ignitible fibers are stored or handled.

Exception: In process of manufacture.

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

Concealed. Rendered inaccessible by the structure or finish of the building. Wires in concealed raceways are considered concealed, even though they may become accessible by withdrawing them. [*See "Accessible. (As applied to wiring methods.)"*]

Conductor.

Bare. A conductor having no covering or electrical insulation whatsoever. *(See "Conductor, Covered.")*

Covered. A conductor encased within material of composition or thickness that is not recognized by this standard as electrical insulation. *(See "Conductor, Bare.")*

Insulated. A conductor encased within material of composition and thickness that is recognized by this standard as electrical insulation.

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.

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.

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.")*

Covered Conductor. See under "Conductor."

Cutout Box. An enclosure designed for surface mounting and having swinging doors or covers secured directly to and telescoping with the walls of the box proper. *(See "Cabinet.")*

Damp Location. See under "Location."

Dead Front. Without live parts exposed to a person on the operating side of the equipment.

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

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.

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.

NOTE: See Part B of this Appendix for definition applying to circuits and equipment over 600 volts, nominal.

Dry Location. See under "Location."

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

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

Enclosure. The case or housing of apparatus, or the fence or walls surrounding an installation to prevent personnel from accidentally contacting energized parts, or to protect the equipment from physical damage.

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

Equipment Grounding Conductor. See "Grounding Conductor, Equipment."

Explosionproof 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 a surrounding flammable atmosphere will not be ignited thereby.

Exposed. (As applied to live parts.) Capable of being inadvertently touched or approached nearer than a safe distance by a person. It is applied to parts not suitably guarded, isolated, or insulated. *(See "Accessible" and "Concealed.")*

Exposed. (As applied to wiring methods.) On or attached to the surface or behind panels designed to allow access. [*See "Accessible. (As applied to wiring methods.")*]

Exposed. For the purposes of Chapter 5, Section E, the word exposed means that the circuit is in such a position that in case of failure of supports or insulation, contact with another circuit may result.

Externally Operable. Capable of being operated without exposing the operator to contact with live parts.

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

Fitting. An accessory such as a locknut, bushing, or other part of a wiring system that is intended primarily to perform a mechanical rather than an electrical function.

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.

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

Grounded Conductor. A system or circuit conductor that is intentionally grounded.

Grounding Conductor. A conductor used to connect equipment or the grounded circuit of a wiring system to a grounding electrode or electrodes.

Grounding Conductor, Equipment. The conductor used to connect the 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.

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.

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.

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 or contact by persons or objects to a point of danger.

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.

Heating Equipment. For the purposes of Chapter 3, Section K(7), the term heating equipment includes any equipment used for heating purposes whose heat is generated by induction or dielectric methods.

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

Identified. Identified, as used in this standard in reference to a conductor or its terminal, means that such conductor or terminal is to be recognized as grounded.

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.

Insulated Conductor. See under "Conductor."

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.

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

Isolated Power System. A system comprising an isolating transformer or its equivalent, a line isolation monitor, and its ungrounded circuit conductors.

Labeled. Equipment or materials to which has been attached a label, symbol or other identifying mark of a nationally recognized testing laboratory, inspection agency, or other organization concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials and by whose labeling is indicated compliance with nationally recognized standards or tests to determine suitable usage in a specified manner.

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

Listed. Equipment or materials included in a list published by a nationally recognized testing laboratory, inspection agency, or other organization concerned with product evaluation, that maintains periodic inspection of production of listed equipment or materials and whose listing states either that the equipment or material meets nationally recognized standards or has been tested and found suitable for use in a specified manner.

NOTE: The means for identifying listed equipment may vary for each testing laboratory, inspection agency or other organization concerned with product evaluation, some of which do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

Location.

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.

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.

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.

Medium Voltage Cable. Type MV medium voltage cable is a single or multiconductor solid dielectric insulated cable rated 2000 volts or higher.

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.

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.

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

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 and of the following types:

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

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

Open Wiring on Insulators. Open wiring on insulators is an exposed wiring method using cleats, knobs, tubes, and flexible tubing for the protection and support of single insulated conductors run in or on buildings, and not concealed by the building structure.

Outlet. A point of the wiring system at which current is taken to supply utilization equipment.

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.

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

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.

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.")*

Panelboard. A single panel or group of panel units designed for assembly in the form of a single panel; including buses, automatic overcurrent devices, and with or without switches for the control of light, heat, or power circuits; designed to be placed in a cabinet or cutout box placed in or against a wall or partition and accessible only from the front. *(See "Switchboard.")*

Permanently Installed Decorative Fountains and Reflection Pools. 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.

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.

Portable X-ray. X-ray equipment designed to be hand-carried.

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.

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.

Power Outlet. An enclosed assembly which may include receptacles, circuit breakers, fuseholders, fused switches, buses and watthour 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.

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.

Qualified Person. One familiar with the construction and operation of the equipment and the hazards involved.

Raceway. A channel designed expressly for holding wires, cables, or busbars, with additional functions as permitted in this standard.

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.

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.")*

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.

Receptacle Outlet. An outlet where one or more receptacles are installed.

Remote-Control Circuit. Any electric circuit that controls any other circuit through a relay or an equivalent device.

Sealable Equipment. Equipment enclosed in a case or cabinet that is provided with a means of sealing or locking so that live parts cannot be made accessible without opening the enclosure. The equipment may or may not be operable without opening the enclosure.

Separately Derived System. A premises wiring system whose power is derived from 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.

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

Service Cable. Service conductors made up in the form of a cable.

Service Conductors. The supply conductors that extend from the street main or from transformers to the service equipment of the premises supplied.

Service Drop. The overhead service conductors from the last pole or other aerial support to and including the splices, if any, connecting to the service-entrance conductors at the building or other structure.

Service-Entrance Cable. 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:

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

(b) 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.

Service-Entrance Conductors, Overhead System. The service conductors between the terminals of the service equipment and a point usually outside the building, clear of building walls, where joined by tap or splice to the service drop.

Service-Entrance Conductors, Underground System. The service conductors between the terminals of the service equipment and the point of connection to the service lateral.

Where service equipment is located outside the building walls, there may be no service-entrance conductors, or they may be entirely outside the building.

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 constitute the main control and means of cutoff of the supply.

Service Raceway. The raceway that encloses the service-entrance conductors.

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.

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.

Sign. See "Electric Sign."

Signaling Circuit. Any electric circuit that energizes signaling equipment.

Special Permission. The written consent of the authority having jurisdiction.

Storable Swimming or Wading Pool. A pool with a maximum dimension of 15 ft and a maximum wall height of 3 ft and is so constructed that it may be readily disassembled for storage and reassembled to its original integrity.

Switches.

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.

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 standard.

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.

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.

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

Transportable X-ray. X-ray equipment to be installed in a vehicle or that may be readily disassembled for transport in a vehicle.

Utilization Equipment. Equipment which utilizes electric energy for mechanical, chemical, heating, lighting, or similar purposes.

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

Volatile Flammable Liquid. A flammable liquid having a flash point below 38°C (100°F) or whose temperature is above its flash point.

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

Some systems, such as 3-phase 4-wire, single-phase 3-wire, and 3-wire direct-current may have various circuits of various voltages.

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.

Voltage to Ground. For grounded circuits, the voltage between the given conductor and that point or conductor of the circuit that is grounded; for ungrounded circuits, the greatest voltage between the given conductor and any other conductor of the circuit.

Watertight. So constructed that moisture will not enter the enclosure.

Weatherproof. So constructed or protected that exposure to the weather will not interfere with successful operation.

Rainproof, raintight, or watertight equipment can fulfill the requirements for weatherproof where varying weather conditions other than wetness, such as snow, ice, dust, or temperature extremes, are not a factor.

Wet Location. See under "Location."

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. Over 600 Volts, Nominal.

Whereas the preceding definitions are intended to apply wherever the terms are used throughout this standard, the following ones are applicable only to the provisions that specifically cover installations and equipment operating at over 600 volts, nominal.

Circuit Breaker. See "Switching Devices."

Cutout. See "Switching Devices."

Disconnect (Isolator). See "Switching Devices."

Disconnecting Means. See "Switching Devices."

Fuse. 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.

Grounded, Effectively. 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.

Interrupter Switch. See "Switching Devices."

Oil (Filled) Cutout. See "Switching Devices."

Power Fuse. See "Fuse."

Switching Device. A device designed to close and/or open one or more electric circuits.

Switching Devices.

Circuit Breaker. 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.

Cutout. 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.

Disconnecting (or Isolating) Switch (Disconnector, Isolator). A mechanical switching device used for isolating a circuit or equipment from a source of power.

Disconnecting Means. A device, group of devices, or other means whereby the conductors of a circuit can be disconnected from their source of supply.

Interrupter Switch. A switch capable of making, carrying, and interrupting specified currents.

Oil Cutout (Oil-Filled Cutout). 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.

Oil Switch. An oil switch is a switch having contacts which operate under oil (or askarel or other suitable liquid).

Appendix B Tables, Notes, and Charts

[RESERVED]

Appendix C Reference Documents

1. *The National Electrical Code,* NFPA 70.