

NFPA 70[®]

National Electrical Code[®]

International Electrical Code[®] Series

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NFPA 70[®]

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2023 Edition

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NFPA 70®

National Electrical Code®

2023 Edition

This edition of *NFPA 70, National Electrical Code*, was prepared by the National Electrical Code Committee and acted on by the NFPA membership during the 2022 NFPA Technical Meeting held June 8–9. It was issued by the Standards Council on August 12, 2022, with an effective date of September 1, 2022, and supersedes all previous editions.

This *Code* was issued with Tentative Interim Amendments (TIAs) that impacted provisions in Article 100, 210.8(F), 215.15, 250.114(3), 250.114(4), 506.5, 506.9(B), 555.30, and 555.35. For more information on TIAs, see www.nfpa.org/70 and Section 5 of the *Regulations Governing the Development of NFPA Standards* available at www.nfpa.org/regs.

This edition of *NFPA 70* was approved as an American National Standard on September 1, 2022.

History and Development of the National Electrical Code®

The National Fire Protection Association has acted as sponsor of the *National Electrical Code* since 1911. The original *Code* document was developed in 1897 as a result of the united efforts of various insurance, electrical, architectural, and allied interests.

In accordance with the *Regulations Governing the Development of NFPA Standards*, a *National Electrical Code* first draft report containing proposed amendments to the 2020 *National Electrical Code* was published by NFPA in June 2021. This report recorded the actions of the various code-making panels and the correlating committee of the National Electrical Code Committee on each public input and first revision that had been made to revise the 2020 *Code*. The report was published at www.nfpa.org/70. Following the close of the public comment period, the code-making panels met, acted on each comment, and created some second revisions, which were reported to the correlating committee. NFPA published the *National Electrical Code* second draft report in March 2022, which recorded the actions of the code-making panels and the correlating committee on the public comments submitted on the National Electrical Code Committee first draft report. The *National Electrical Code* first and second draft reports were presented to the 2022 June Association Technical Meeting for adoption.

NFPA has an Electrical Section that provides an opportunity for NFPA members interested in electrical safety to become better informed and to contribute to the development of the *National Electrical Code* and other NFPA electrical standards. At the Electrical Section business meeting/codes and standards review session held at the 2022 NFPA Conference and Expo, section members had the opportunity to discuss and review the report of the National Electrical Code Committee prior to the adoption of this edition of the *Code* by the association at its 2022 June Technical Meeting.

This 56th edition supersedes all other previous editions, supplements, and printings dated 1897, 1899, 1901, 1903, 1904, 1905, 1907, 1909, 1911, 1913, 1915, 1918, 1920, 1923, 1925, 1926, 1928, 1930, 1931, 1933, 1935, 1937, 1940, 1942, 1943, 1947, 1949, 1951, 1953, 1954, 1955, 1956, 1957, 1958, 1959, 1962, 1965, 1968, 1971, 1975, 1978, 1981, 1984, 1987, 1990, 1993, 1996, 1999, 2002, 2005, 2008, 2011, 2014, 2017, and 2020.

This *Code* is purely advisory as far as NFPA is concerned. It is made available for a wide variety of both public and private uses in the interest of life and property protection. These include both use in law and for regulatory purposes and use in private self-regulation and standardization activities such as insurance underwriting, building and facilities construction and management, and product testing and certification.

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NATIONAL ELECTRICAL CODE COMMITTEE

Committee Scope: This Committee shall have primary responsibility for documents on minimizing the risk of electricity as a source of electric shock and as a potential ignition source of fires and explosions. It shall also be responsible for text to minimize the propagation of fire and explosions due to electrical installations.

These lists represent the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of this document.

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Code-Making Panel No. 4

Articles 690, 691, 692, 694, 705, 710

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Code-Making Panel No. 5

Articles 200, 250

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Code-Making Panel No. 6

Articles 310, 315, 320, 322, 324, 326, 330, 332, 334, 336, 337, 338, 340, 382, 394, 395, 396, 398, 400, 402,

Chapter 9 Tables 5 through 9, Annex B, Annex D Example D7, Annex E

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Rep. The Vinyl Institute

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Code-Making Panel No. 7

Articles 220 Part VII, 545, 547, 550, 551, 552, 555, 604, 675, Annex D Examples D11 and D12

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Code-Making Panel No. 8

Articles 342, 344, 348, 350, 352, 353, 354, 355, 356, 358, 360, 362, 366, 368, 369, 370, 371, 372, 374, 376, 378, 380, 384, 386, 388, 390, 392, Chapter 9 Tables 1, 2, 4, Annex C, Annex D Example D13

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Code-Making Panel No. 9

Articles 312, 314, 404, 408, 450, 495

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Articles 215, 225, 230, 235, 240, 242, 245

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Code-Making Panel No. 11

Articles 409, 430, 440, 460, 470, Annex D Example D8

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Code-Making Panel No. 12

Articles 610, 620, 625, 626, 630, 640, 645, 646, 647, 650, 660, 665, 668, 669, 670, 685, Annex D Examples D9 and D10

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Code-Making Panel No. 13

Articles 445, 455, 480, 695, 700, 701, 702, 706, 708, 750, Annex F, Annex G

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Code-Making Panel No. 14

Articles 500, 501, 502, 503, 504, 505, 506, 511, 512, 513, 514, 515, 516

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Code-Making Panel No. 15

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NFPA 70

National Electrical Code

2023 Edition

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ARTICLE 90

Introduction

90.1 Scope. This article covers use and application, arrangement, and enforcement of this *Code*. It also covers the expression of mandatory, permissive, and nonmandatory text, provides guidance on the examination of equipment and on wiring planning, and specifies the use and expression of measurements.

90.2 Use and Application.

(A) Practical Safeguarding. The purpose of this *Code* is the practical safeguarding of persons and property from hazards arising from the use of electricity. This *Code* is not intended as a design specification or an instruction manual for untrained persons.

(B) Adequacy. This *Code* contains provisions that are considered necessary for safety. Compliance therewith and proper maintenance result in an installation that is essentially free from hazard but not necessarily efficient, convenient, or adequate for good service or future expansion of electrical use.

Informational Note: Hazards often occur because of overloading of wiring systems by methods or usage not in conformity with this *Code*. This occurs because initial wiring did not provide for increases in the use of electricity. An initial adequate installation and reasonable provisions for system changes provide for future increases in the use of electricity.

(C) Installations Covered. This *Code* covers the installation and removal of electrical conductors, equipment, and raceways;

signaling and communications conductors, equipment, and raceways; and optical fiber cables for the following:

- (1) Public and private premises, including buildings, structures, mobile homes, recreational vehicles, and floating buildings
- (2) Yards, lots, parking lots, carnivals, and industrial substations
- (3) Installations of conductors and equipment that connect to the supply of electricity
- (4) Installations used by the electric utility, such as office buildings, warehouses, garages, machine shops, and recreational buildings, that are not an integral part of a generating plant, substation, or control center
- (5) Installations supplying shore power to ships and watercraft in marinas and boatyards, including monitoring of leakage current
- (6) Installations used to export electric power from vehicles to premises wiring or for bidirectional current flow

(D) Installations Not Covered. This *Code* does not cover the following:

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

Informational Note: Although the scope of this *Code* indicates that the *Code* does not cover installations in ships, portions of this *Code* are incorporated by reference into Title 46, Code of Federal Regulations, Parts 110–113.

- (2) Installations underground in mines and self-propelled mobile surface mining machinery and its attendant electrical trailing cable
- (3) Installations of railways for generation, transformation, transmission, energy storage, or distribution of power used exclusively for operation of rolling stock or installations used exclusively for signaling and communications purposes
- (4) Installations of communications equipment under the exclusive control of communications utilities located outdoors or in building spaces used exclusively for such installations
- (5) Installations under the exclusive control of an electric utility where such installations
 - a. Consist of service drops or service laterals, and associated metering, or
 - b. Are on property owned or leased by the electric utility for the purpose of communications, metering, generation, control, transformation, transmission, energy storage, or distribution of electric energy, or
 - c. Are located in legally established easements or rights-of-way, or
 - d. Are located by other written agreements either designated by or recognized by public service commissions, utility commissions, or other regulatory agencies having jurisdiction for such installations. These written agreements shall be limited to installations for the purpose of communications, metering, generation, control, transformation, transmission, energy storage, or distribution of electric energy where legally established easements or rights-of-way cannot be obtained. These installations shall be limited to federal lands, Native American reservations through the U.S. Department of the Interior Bureau of Indian Affairs, military bases, lands controlled by port authorities

and state agencies and departments, and lands owned by railroads.

Informational Note to (4) and (5): Examples of utilities may include those entities that are typically designated or recognized by governmental law or regulation by public service/utility commissions and that install, operate, and maintain electric supply (such as generation, transmission, or distribution systems) or communications systems (such as telephone, CATV, Internet, satellite, or data services). Utilities may be subject to compliance with codes and standards covering their regulated activities as adopted under governmental law or regulation. Additional information can be found through consultation with the appropriate governmental bodies, such as state regulatory commissions, the Federal Energy Regulatory Commission, and the Federal Communications Commission.

Δ (E) Relation to Other International Standards. The requirements in this *Code* address the fundamental principles of protection for safety contained in Section 131 of International Electrotechnical Commission Standard 60364-1, *Low-voltage Electrical Installations – Part 1: Fundamental Principles, Assessment of General Characteristics, Definitions*.

Informational Note: See IEC 60364-1, *Low-voltage Electrical Installations – Part 1: Fundamental Principles, Assessment of General Characteristics, Definitions*, Section 131, for fundamental principles of protection for safety that encompass protection against electric shock, protection against thermal effects, protection against overcurrent, protection against fault currents, and protection against overvoltage. All of these potential hazards are addressed by the requirements in this *Code*.

(F) Special Permission. The authority having jurisdiction for enforcing this *Code* may grant exception for the installation of conductors and equipment that are not under the exclusive control of the electric utilities and are used to connect the electric utility supply system to the service conductors of the premises served, provided such installations are outside a building or structure, or terminate inside at a readily accessible location nearest the point of entrance of the service conductors.

90.3 Code Arrangement. This *Code* is divided into the introduction and nine chapters, as shown in Figure 90.3. Chapters 1, 2, 3, and 4 apply generally. Chapters 5, 6, and 7 apply to special occupancies, special equipment, or other special conditions and may supplement or modify the requirements in Chapters 1 through 7.

Chapter 8 covers communications systems and is not subject to the requirements of Chapters 1 through 7 except where the requirements are specifically referenced in Chapter 8.

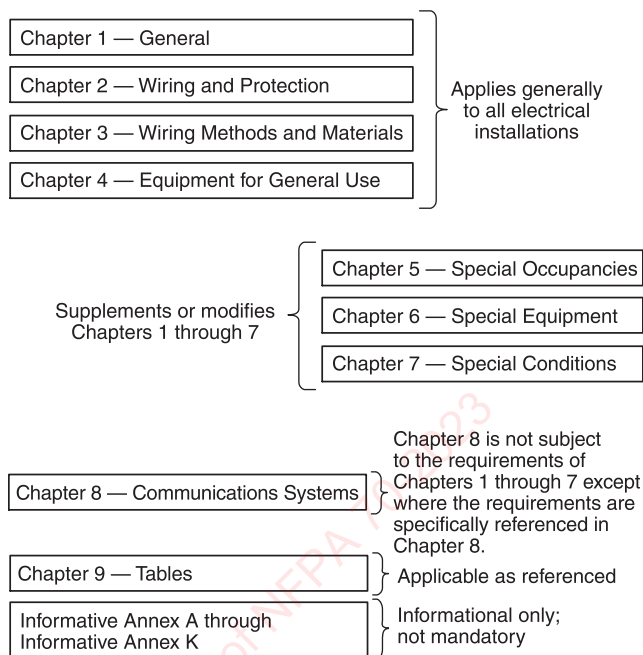
Chapter 9 consists of tables that are applicable as referenced.

Informative annexes are not part of the requirements of this *Code* but are included for informational purposes only.

Δ 90.4 Enforcement.

N (A) Application. This *Code* is intended to be suitable for mandatory application by governmental bodies that exercise legal jurisdiction over electrical installations, including signaling and communications systems, and for use by insurance inspectors.

N (B) Interpretations. The authority having jurisdiction for enforcement of the *Code* has the responsibility for making interpretations of the rules, for deciding on the approval of equipment and materials, and for granting the special permission contemplated in a number of the rules.



Δ FIGURE 90.3 Code Arrangement.

N (C) Specific Requirements and Alternative Methods. By special permission, the authority having jurisdiction may waive specific requirements in this *Code* or permit alternative methods where it is assured that equivalent objectives can be achieved by establishing and maintaining effective safety.

N (D) New Products, Constructions, or Materials. This *Code* may require new products, constructions, or materials that may not yet be available at the time the *Code* is adopted. In such event, the authority having jurisdiction may permit the use of the products, constructions, or materials that comply with the most recent previous edition of this *Code* adopted by the jurisdiction.

Informational Note: See Informative Annex H, Administration and Enforcement, for a model of guidelines that can be used to create an electrical inspection and enforcement program and to adopt NFPA 70, *National Electrical Code*.

90.5 Mandatory Rules, Permissive Rules, and Explanatory Material.

(A) Mandatory Rules. Mandatory rules of this *Code* are those that identify actions that are specifically required or prohibited and are characterized by the use of the terms *shall* or *shall not*.

(B) Permissive Rules. Permissive rules of this *Code* are those that identify actions that are allowed but not required, are normally used to describe options or alternative methods, and are characterized by the use of the terms *shall be permitted* or *shall not be required*.

(C) Explanatory Material. Explanatory material, such as references to other standards, references to related sections of this *Code*, or information related to a *Code* rule, is included in this *Code* in the form of informational notes or an informative annex. Unless the standard reference includes a date, the reference is to be considered as the latest edition of the standard. Such notes are informational only and are not enforceable as requirements of this *Code*.

Brackets containing section references to another NFPA document are for informational purposes only and are provided as a guide to indicate the source of the extracted text. These bracketed references immediately follow the extracted text.

Informational Note: The format and language used in this *Code* follows guidelines established by NFPA and published in the *NEC Style Manual*. Copies of this manual can be obtained from NFPA.

(D) Informative Annexes. Nonmandatory information relative to the use of the *NEC* is provided in informative annexes. Informative annexes are not part of the enforceable requirements of the *NEC*, but are included for information purposes only.

90.6 Formal Interpretations. To promote uniformity of interpretation and application of this *Code*, formal interpretation procedures have been established and are found in the *Regulations Governing the Development of NFPA Standards*.

Δ 90.7 Examination of Equipment for Safety. For specific items of equipment and materials referred to in this *Code*, examinations for safety made under standard conditions provide a basis for approval where the record is made generally available through promulgation by organizations properly equipped and qualified for experimental testing, inspections of the run of goods at factories, and service-value determination through field inspections. This avoids the necessity for repetition of examinations by different examiners, frequently with inadequate facilities for such work, and the confusion that would result from conflicting reports on the suitability of devices and materials examined for a given purpose.

It is the intent of this *Code* that factory-installed internal wiring or the construction of equipment need not be inspected at the time of installation of the equipment, except to detect alterations or damage, if the equipment has been listed by a qualified electrical testing laboratory that is recognized as having the facilities described in the preceding paragraph and that requires suitability for installation in accordance with this *Code*. Suitability shall be determined by application of requirements that are compatible with this *Code*.

Informational Note No. 1: See 110.3 for guidance on safety examinations.

Informational Note No. 2: See Article 100 for definitions of *Listed* and *Reconditioned*.

Informational Note No. 3: See Informative Annex A for a list of product safety standards that are compatible with this *Code*.

90.8 Wiring Planning.

(A) Future Expansion and Convenience. Plans and specifications that provide ample space in raceways, spare raceways, and additional spaces allow for future increases in electric power and communications circuits. Distribution centers located in readily accessible locations provide convenience and safety of operation.

(B) Number of Circuits in Enclosures. It is elsewhere provided in this *Code* that the number of circuits confined in a single enclosure be varyingly restricted. Limiting the number of circuits in a single enclosure minimizes the effects from a short circuit or ground fault.

90.9 Units of Measurement.

(A) Measurement System of Preference. For the purpose of this *Code*, metric units of measurement are in accordance with the modernized metric system known as the International System of Units (SI).

(B) Dual System of Units. SI units shall appear first, and inch-pound units shall immediately follow in parentheses. Conversion from inch-pound units to SI units shall be based on hard conversion except as provided in 90.9(C).

Exception: The tables located in Informative Annex C shall be permitted to list the trade sizes before SI units.

(C) Permitted Uses of Soft Conversion. The cases given in 90.9(C)(1) through (C)(4) shall not be required to use hard conversion and shall be permitted to use soft conversion.

(1) Trade Sizes. Where the actual measured size of a product is not the same as the nominal size, trade size designators shall be used rather than dimensions. Trade practices shall be followed in all cases.

(2) Extracted Material. Where material is extracted from another standard, the context of the original material shall not be compromised or violated. Any editing of the extracted text shall be confined to making the style consistent with that of the *NEC*.

(3) Industry Practice. Where industry practice is to express units in inch-pound units, the inclusion of SI units shall not be required.

(4) Safety. Where a negative impact on safety would result, soft conversion shall be used.

(D) Compliance. Conversion from inch-pound units to SI units shall be permitted to be an approximate conversion. Compliance with the numbers shown in either the SI system or the inch-pound system shall constitute compliance with this *Code*.

Informational Note No. 1: Hard conversion is considered a change in dimensions or properties of an item into new sizes that might or might not be interchangeable with the sizes used in the original measurement. Soft conversion is considered a direct mathematical conversion and involves a change in the description of an existing measurement but not in the actual dimension.

Informational Note No. 2: SI conversions are based on IEEE/ASTM SI 10-1997, *Standard for the Use of the International System of Units (SI): The Modern Metric System*.

Chapter 1 General

ARTICLE 100

Definitions

N Scope. This article contains only those definitions essential to the application of this *Code*. It is not intended to include commonly defined general terms or commonly defined technical terms from related codes and standards. An article number in parentheses following the definition indicates that the definition only applies to that article.

Informational Note: A definition that is followed by a reference in brackets has been extracted from one of the following standards. Only editorial changes were made to the extracted text to make it consistent with this *Code*.

- (1) NFPA 30A-2021, *Code for Motor Fuel Dispensing Facilities and Repair Garages*
- (2) NFPA 33-2021, *Standard for Spray Application Using Flammable or Combustible Materials*
- (3) NFPA 75-2020, *Standard for the Fire Protection of Information Technology Equipment*
- (4) NFPA 79-2021, *Electrical Standard for Industrial Machinery*
- (5) NFPA 99-2021, *Health Care Facilities Code*
- (6) NFPA 101®-2022, *Life Safety Code®*
- (7) NFPA 110-2019, *Standard for Emergency and Standby Power Systems*
- (8) NFPA 303-2021, *Fire Protection Standard for Marinas and Boatyards*
- (9) NFPA 307-2021, *Standard for the Construction and Fire Protection of Marine Terminals, Piers, and Wharves*
- (10) NFPA 499-2021, *Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas*
- (11) NFPA 501-2022, *Standard on Manufactured Housing*
- (12) NFPA 790-2021, *Standard for Competency of Third-Party Field Evaluation Bodies*
- (13) NFPA 1192-2021, *Standard on Recreational Vehicles*

Accessible (as applied to equipment). Capable of being reached for operation, renewal, and inspection. (CMP-1)

Accessible (as applied to wiring methods). Capable of being removed or exposed without damaging the building structure or finish or not permanently closed in or blocked by the structure, other electrical equipment, other building systems, or finish of the building. (CMP-1)

Accessible, Readily (Readily Accessible). Capable of being reached quickly for operation, renewal, or inspections without requiring those to whom ready access is requisite to take actions such as to use tools (other than keys), to climb over or under, to remove obstacles, or to resort to portable ladders, and so forth. (CMP-1)

Informational Note: Use of keys is a common practice under controlled or supervised conditions and a common alternative to the ready access requirements under such supervised conditions as provided elsewhere in the *NEC*.

N Adapter. A device used to adapt a circuit from one configuration of an attachment plug or receptacle to another configuration with the same current rating. (520) (CMP-15)

Adjustable Speed Drive. Power conversion equipment that provides a means of adjusting the speed of an electric motor. (CMP-11)

Informational Note: A variable frequency drive is one type of electronic adjustable speed drive that controls the rotational speed of an ac electric motor by controlling the frequency and voltage of the electrical power supplied to the motor.

Adjustable Speed Drive System. A combination of an adjustable speed drive, its associated motor(s), and auxiliary equipment. (CMP-11)

Aircraft Painting Hangar. An aircraft hangar constructed for the express purpose of spraying, coating, and/or dipping applications and provided with dedicated ventilation supply and exhaust. (CMP-14)

N Alternate Power Source. One or more generator sets, or battery systems where permitted, intended to provide power during the interruption of the normal electrical service; or the public utility electrical service intended to provide power during interruption of service normally provided by the generating facilities on the premises. [99:3.3.4] (517) (CMP-15)

N Ambulatory Health Care Occupancy. An occupancy used to provide services or treatment simultaneously to four or more patients that provides, on an outpatient basis, one or more of the following:

- (1) Treatment for patients that renders the patients incapable of taking action for self-preservation under emergency conditions without the assistance of others.
- (2) Anesthesia that renders the patients incapable of taking action for self-preservation under emergency conditions without the assistance of others.
- (3) Treatment for patients who, due to the nature of their injury or illness, are incapable of taking action for self-preservation under emergency conditions without the assistance of others.

[101:3.3.198.1] (517) (CMP-15)

Ampacity. The maximum current, in amperes, that a conductor can carry continuously under the conditions of use without exceeding its temperature rating. (CMP-6)

N Amplifier (Audio Amplifier) (Pre-Amplifier). Electronic equipment that increases the current or voltage, or both, of an audio signal intended for use by another piece of audio equipment. Amplifier is the term used to denote an audio amplifier. (640) (CMP-12)

Appliance. Utilization equipment, generally other than industrial, that is fastened in place, stationary, or portable; is normally built in a standardized size or type; and is installed or connected as a unit to perform one or more functions such as clothes washing, air-conditioning, food mixing, deep frying, and so forth. (CMP-17)

N Applicator. The device used to transfer energy between the output circuit and the object or mass to be heated. (665) (CMP-12)

Approved. Acceptable to the authority having jurisdiction. (CMP-1)

Arc-Fault Circuit Interrupter (AFCI). A device intended to provide protection from the effects of arc faults by recognizing characteristics unique to arcing and by functioning to de-energize the circuit when an arc fault is detected. (CMP-2)

Array. A mechanically and electrically integrated grouping of modules with support structure, including any attached system components such as inverter(s) or dc-to-dc converter(s) and attached associated wiring. (690) (CMP-4)

Askarel. A generic term for a group of nonflammable synthetic chlorinated hydrocarbons used as electrical insulating media. (CMP-9)

Informational Note: 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 on the askarel type.

Associated Apparatus. Apparatus in which the circuits are not necessarily intrinsically safe themselves but that affects the energy in the intrinsically safe circuits and is relied on to maintain intrinsic safety. Such apparatus is one of the following:

- (1) Electrical apparatus that has an alternative type of protection for use in the appropriate hazardous (classified) location
- (2) Electrical apparatus not so protected that shall not be used within a hazardous (classified) location

(CMP-14)

Informational Note No. 1: Associated apparatus has identified intrinsically safe connections for intrinsically safe apparatus and also **might** have connections for nonintrinsically safe apparatus.

Informational Note No. 2: An example of associated apparatus is an intrinsic safety barrier, which is a network designed to limit the energy (voltage and current) available to the protected circuit in the hazardous (classified) location under specified fault conditions.

Informational Note No. 3: See ANSI/UL 913, *Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations*; ANSI/UL 60079-11, *Explosive Atmospheres — Part 11: Equipment Protection by Intrinsic Safety “i”*; and ANSI/ISA RP 12.06.01, *Recommended Practice for Wiring Methods for Hazardous (Classified) Locations Instrumentation — Part 1: Intrinsic Safety*, for additional information.

Associated Nonincendive Field Wiring Apparatus. Apparatus in which the circuits are not necessarily nonincendive themselves but that affects the energy in nonincendive field wiring circuits and is relied on to maintain nonincendive energy levels. Such apparatus is one of the following:

- (1) Electrical apparatus that has an alternative type of protection for use in the appropriate hazardous (classified) location
- (2) Electrical apparatus not so protected that shall not be used within a hazardous (classified) location

(CMP-14)

Informational Note No. 1: Associated nonincendive field wiring apparatus has designated associated nonincendive field wiring apparatus connections for nonincendive field wiring apparatus and also **might** have connections for other electrical apparatus.

Informational Note No. 2: See ANSI/UL 121201, *Nonincendive Electrical Equipment for Use in Class I and II, Division 2 and Class III, Divisions 1 and 2 Hazardous (Classified) Locations*, for additional information.

Attachment Fitting, Weight-Supporting (WSAF) (Weight-Supporting Attachment Fitting). A device that, by insertion into a weight-supporting ceiling receptacle, establishes a connection between the conductors of the attached utilization equipment and the branch-circuit conductors connected to the weight-supporting ceiling receptacle. (CMP-18)

Informational Note No. 1: A weight-supporting attachment fitting is different from an attachment plug because no cord is associated with the fitting. A weight-supporting attachment fitting in combination with a weight-supporting ceiling receptacle secures the associated utilization equipment in place and supports its weight.

Informational Note No. 2: See ANSI/NEMA WD 6, *American National Standard for Wiring Devices — Dimensional Specifications*, for the standard configuration of weight-supporting attachment fittings and related weight-supporting ceiling receptacles.

Attachment Plug (Plug Cap) (Plug). A device that, by insertion in a receptacle, establishes a connection between the conductors of the attached flexible cord and the conductors connected permanently to the receptacle. (CMP-18)

Audio Autotransformer. A transformer with a single winding and multiple taps intended for use with an amplifier loudspeaker signal output. (640) (CMP-12)

Audio Signal Processing Equipment (Audio Equipment). Electrically operated equipment that produces, processes, or both, electronic signals that, when appropriately amplified and reproduced by a loudspeaker, produce an acoustic signal within the range of normal human hearing (typically 20–20 kHz). Within Article 640, the terms equipment and audio equipment are assumed to be equivalent to audio signal processing equipment. (640) (CMP-12)

Informational Note: This equipment includes, but is not limited to, loudspeakers; headphones; pre-amplifiers; microphones and their power supplies; mixers; MIDI (musical instrument digital interface) equipment or other digital control systems; equalizers, compressors, and other audio signal processing equipment; and audio media recording and playback equipment, including turntables, tape decks and disk players (audio and multimedia), synthesizers, tone generators, and electronic organs. Electronic organs and synthesizers may have integral or separate amplification and loudspeakers. With the exception of amplifier outputs, virtually all such equipment is used to process signals (using analog or digital techniques) that have nonhazardous levels of voltage or current.

Audio System. The totality of all equipment and interconnecting wiring used to fabricate a fully functional audio signal processing, amplification, and reproduction system. (640) (CMP-12)

Audio Transformer. A transformer with two or more electrically isolated windings and multiple taps intended for use with an amplifier loudspeaker signal output. (640) (CMP-12)

Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure. (CMP-1)

Informational Note: The phrase “authority having jurisdiction,” or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or

health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

Automatic. Performing a function without the necessity of human intervention. (CMP-1)

Δ Bathroom. An area including a sink with one or more of the following: a toilet, a urinal, a tub, a shower, a bidet, or similar plumbing fixtures. (CMP-2)

N Battery. A single cell or a group of cells connected together electrically in series, in parallel, or a combination of both. (CMP-13)

N Battery, Flow. (Flow Battery) An energy storage component that stores its active materials in the form of one or two electrolytes external to the reactor interface. When in use, the electrolytes are transferred between reactor and storage tanks. (706) (CMP-13)

Informational Note: Three commercially available flow battery technologies are zinc air, zinc bromine, and vanadium redox, sometimes referred to as *pumped electrolyte ESS*.

N Battery, Sealed. (Sealed Battery) A battery that has no provision for the routine addition of water or electrolyte or for external measurement of electrolyte specific gravity and might contain pressure relief venting. (CMP-13)

N Battery, Stationary Standby. (Stationary Standby Battery) A battery that spends the majority of the time on continuous float charge or in a high state of charge, in readiness for a discharge event. (CMP-13)

Informational Note: Uninterruptible Power Supply (UPS) batteries are an example that falls under this definition.

N Battery-Powered Lighting Units. Individual unit equipment for backup illumination consisting of a rechargeable battery; a battery-charging means; provisions for one or more lamps mounted on the equipment, or with terminals for remote lamps, or both; and a relaying device arranged to energize the lamps automatically upon failure of the supply to the unit equipment. (517) (CMP-15)

N Berth. The water space to be occupied by a boat or other vessel alongside or between bulkheads, piers, piles, fixed and floating docks, or any similar access structure. [303:3.3.2] (555) (CMP-7)

Informational Note: See the definition of *Slip* for additional information.

N Bipolar Circuit. A dc circuit that is comprised of two monopole circuits, each having an opposite polarity connected to a common reference point. (CMP-4)

N Block. A square or portion of a city, town, or village enclosed by streets and including the alleys so enclosed, but not any street. (800) (CMP-16)

N Boatyard. A facility used for constructing, repairing, servicing, hauling from the water, storing (on land and in water), and launching of boats. [303:3.3.3] (555) (CMP-7)

N Bodies of Water, Artificially Made. (Artificially Made Bodies of Water) Bodies of water that have been constructed or modified to fit some decorative or commercial purpose such as, but not limited to, aeration ponds, fish farm ponds, storm retention basins, treatment ponds, and irrigation (channel) facilities. Water depths may vary seasonally or be controlled. (682) (CMP-17)

N Bodies of Water, Natural. (Natural Bodies of Water) Bodies of water such as lakes, streams, ponds, rivers, and other naturally occurring bodies of water, which may vary in depth throughout the year. (682) (CMP-17)

Bonded (Bonding). Connected to establish electrical continuity and conductivity. (CMP-5)

Bonding Conductor (Bonding Jumper). A conductor that ensures the required electrical conductivity between metal parts that are required to be electrically connected. (CMP-5)

Bonding Jumper, Equipment. (Equipment Bonding Jumper) The connection between two or more portions of the equipment grounding conductor. (CMP-5)

Bonding Jumper, Main. (Main Bonding Jumper) The connection between the grounded circuit conductor and the equipment grounding conductor, or the supply-side bonding jumper, or both, at the service. (CMP-5)

Bonding Jumper, Supply-Side. (Supply-Side Bonding Jumper) A conductor installed on the supply side of a service or within a service equipment enclosure(s), or for a separately derived system, that ensures the required electrical conductivity between metal parts required to be electrically connected. (CMP-5)

Bonding Jumper, System. (System Bonding Jumper) The connection between the grounded circuit conductor and the supply-side bonding jumper, or the equipment grounding conductor, or both, at a separately derived system. (CMP-5)

N Border Light. A permanently installed overhead strip light. (520) (CMP-15)

N Bottom Shield. A protective layer that is installed between the floor and flat conductor cable (Type FCC) to protect the cable from physical damage and may or may not be incorporated as an integral part of the cable. (324) (CMP-6)

Branch Circuit (Branch-Circuit). The circuit conductors between the final overcurrent device protecting the circuit and the outlet(s). (CMP-2)

Branch Circuit, Appliance. (Appliance Branch Circuit) A branch circuit that supplies energy to one or more outlets to which appliances are to be connected and that has no permanently connected luminaires that are not a part of an appliance. (CMP-2)

Branch Circuit, General-Purpose. (General-Purpose Branch Circuit) A branch circuit that supplies two or more receptacles or outlets for lighting and appliances. (CMP-2)

Branch Circuit, Individual. (Individual Branch Circuit) A branch circuit that supplies only one utilization equipment. (CMP-2)

N Branch Circuit, Motor. (Motor Branch Circuit) The circuit conductors, including equipment, between the motor branch-

circuit short-circuit and ground-fault protective device and an individual motor. (CMP-11)

Δ Branch Circuit, Multiwire. (Multiwire Branch Circuit) A branch circuit that consists of two or more ungrounded conductors that have a voltage between them, and a **neutral** conductor that has equal voltage between it and each ungrounded conductor of the circuit and that is connected to the neutral conductor of the system. (CMP-2)

N Branch-Circuit Selection Current (BCSC). The value in amperes to be used instead of the rated-load current in determining the ratings of motor branch-circuit conductors, disconnecting means, controllers, and branch-circuit short-circuit and ground-fault protective devices wherever the running overload protective device permits a sustained current greater than the specified percentage of the rated-load current. The value of branch-circuit selection current will always be equal to or greater than the marked rated-load current. (440) (CMP-11)

N Breakout Assembly. An adapter used to connect a multipole connector containing two or more branch circuits to multiple individual branch-circuit connectors. (520) (CMP-15)

N Broadband. Wide bandwidth data transmission that transports multiple signals, protocols, and traffic types over various media types. (CMP-16)

Building. A structure that stands alone or that is separated from adjoining structures by fire walls. (CMP-1)

N Building, Floating. (Floating Building) A building that floats on water, is moored in a permanent location, and has a premises wiring system served through connection by permanent wiring to an electrical supply system not located on the premises. (CMP-7)

N Building, Manufactured. (Manufactured Building) Any building that is of closed construction and is made or assembled in manufacturing facilities on or off the building site for installation, or for assembly and installation on the building site, other than manufactured homes, mobile homes, park trailers, or recreational vehicles. (545) (CMP-7)

N Building Component. Any subsystem, subassembly, or other system designed for use in or integral with or as part of a structure, which can include structural, electrical, mechanical, plumbing, and fire protection systems, and other systems affecting health and safety. (545) (CMP-7)

N Building System. Plans, specifications, and documentation for a building of manufactured building or for a type or a system of building components, which can include structural, electrical, mechanical, plumbing, and fire protection systems, and other systems affecting health and safety, and including such variations thereof as are specifically permitted by regulation, and which variations are submitted as part of the building system or amendment thereto. (545) (CMP-7)

N Bulkhead. A vertical structural wall, usually of stone, timber, metal, concrete, or synthetic material, constructed along, and generally parallel to, the shoreline to retain earth as an extension of the upland, and often to provide suitable water depth at the waterside face. [303:3.3.5] (555) (CMP-7)

N Bull Switch. An externally operated wall-mounted safety switch that can contain overcurrent protection and is designed for the connection of portable cables and cords. (530) (CMP-15)

N Bundled. Cables or conductors that are tied, wrapped, taped, or otherwise periodically bound together. (520) (CMP-15)

N Busbar. A noninsulated conductor electrically connected to the source of supply and physically supported on an insulator providing a power rail for connection to utilization equipment, such as sensors, actuators, A/V devices, low-voltage luminaire assemblies, and similar electrical equipment. (393) (CMP-18)

N Busbar Support. An insulator that runs the length of a section of suspended ceiling bus rail that serves to support and isolate the busbars from the suspended grid rail. (393) (CMP-18)

N Busway. A raceway consisting of a metal enclosure containing factory-mounted, bare or insulated conductors, which are usually copper or aluminum bars, rods, or tubes. (CMP-8)

Cabinet. An enclosure that is designed for either surface mounting or flush mounting and is provided with a frame, mat, or trim in which a swinging door or doors are or can be hung. (CMP-9)

N Cable, Abandoned. (Abandoned Cable) Installed cable that is not terminated at equipment other than a termination fitting or a connector and is not identified for future use with a tag. (CMP-16)

Informational Note: See 640.6(B), 645.5(G), 722.25, 760.25, 770.25, and 800.25 for requirements covering the removal of abandoned cables.

N Cable, Armored (Type AC). (Armored Cable) A fabricated assembly of insulated conductors in a flexible interlocked metallic armor. (CMP-6)

Δ Cable, Circuit Integrity (CI). (Circuit Integrity Cable) Cable(s) marked with the suffix “-CI” used for remote-control, signaling, power-limited, fire alarm, optical fiber, or communications systems that supply critical circuits to ensure survivability for continued circuit operation for a specified time under fire conditions. (CMP-3)

Informational Note: See 728.4 for power circuits installed for survivability.

Cable, Coaxial. (Coaxial Cable) A cylindrical assembly composed of a conductor centered inside a metallic tube or shield, separated by a dielectric material, and usually covered by an insulating jacket. (CMP-16)

N Cable, Festoon. (Festoon Cable) Single- and multiple-conductor cable intended for use and installation where flexibility is required. (610) (CMP-12)

N Cable, Flat Conductor (Type FCC). (Flat Conductor Cable) Three or more separate flat copper conductors placed horizontally edge-to-edge and enclosed within an insulating assembly. (324) (CMP-6)

N Cable, Instrumentation Tray (Type ITC). (Instrumentation Tray Cable) A factory assembly of two or more insulated conductors, with or without an equipment grounding conductor(s), enclosed in a nonmetallic sheath. (CMP-3)

N Cable, Integrated Gas Spacer (Type IGS). (Integrated Gas Spacer Cable) A factory assembly of one or more conductors, each individually insulated and enclosed in a loose fit, nonmetallic flexible conduit as an integrated gas spacer cable rated 0 volts through 600 volts. (CMP-6)

N Cable, Limited Use. (Limited-Use Cable) Cables that are intended to be used with protection such as a raceway or for specific restricted applications. (722) (CMP-3)

N Cable, Medium Voltage (Type MV). (Medium Voltage Cable) A single or multiconductor solid dielectric insulated cable rated 2001 volts up to and including 35,000 volts, nominal. (CMP-6)

N Cable, Metal Clad (Type MC). (Metal Clad Cable) A factory assembly of one or more insulated circuit conductors with or without optical fiber members enclosed in an armor of interlocking metal tape, or a smooth or corrugated metallic sheath. (CMP-6)

N Cable, Metallic Conductor. (Metallic Conductor Cable) A factory assembly of two or more conductors having an overall covering. (CMP-16)

N Cable, Mineral-Insulated, Metal-Sheathed (Type MI). (Mineral-Insulated, Metal-Sheathed Cable) A factory assembly of one or more conductors insulated with a highly compressed refractory mineral insulation and enclosed in a liquidtight and gastight continuous copper or alloy steel sheath. (CMP-6)

N Cable, Nonmetallic-Sheathed. A factory assembly of two or more insulated conductors enclosed within an overall nonmetallic jacket. (CMP-6)

N Cable, Nonmetallic-Sheathed (Type NM). Insulated conductors enclosed within an overall nonmetallic jacket. (CMP-6)

N Cable, Nonmetallic-Sheathed (Type NMC). Insulated conductors enclosed within an overall, corrosion resistant, nonmetallic jacket. (CMP-6)

Cable, Optical Fiber. (Optical Fiber Cable) A factory assembly or field assembly of one or more optical fibers having an overall covering. (CMP-16)

Informational Note: A field-assembled optical fiber cable is an assembly of one or more optical fibers within a jacket. The jacket, without optical fibers, is installed in a manner similar to conduit or raceway. Once the jacket is installed, the optical fibers are inserted into the jacket, completing the cable assembly.

Cable, Optical Fiber, Conductive. (Conductive Optical Fiber Cable) A factory assembly of one or more optical fibers having an overall covering and containing non-current-carrying conductive member(s) such as metallic strength member(s), metallic vapor barrier(s), metallic armor, or metallic sheath. (CMP-16)

Cable, Optical Fiber, Hybrid. (Hybrid Optical Fiber Cable) A cable containing optical fibers and current-carrying electrical conductors. (CMP-16)

Cable, Optical Fiber, Nonconductive. (Nonconductive Optical Fiber Cable) A factory assembly of one or more optical fibers having an overall covering and containing no electrically conductive materials. (CMP-16)

Δ Cable, Optical Fiber, Protected. (Protected Optical Fiber Cable) Optical fiber cable protected from releasing optical radiation into the atmosphere during normal operating conditions and foreseeable malfunctions by additional armoring, conduit, cable tray, or raceway. (CMP-14)

Informational Note: See ANSI/UL 60079-28, *Explosive Atmospheres — Part 28: Protection of Equipment and Transmission Systems Using Optical Radiation*, for additional information.

N Cable, Portable Power Feeder. (Portable Power Feeder Cable) One or more flexible shielded insulated power conductors enclosed in a flexible covering rated from 2001 to 25,000 volts. (CMP-6)

N Cable, Power and Control Tray (Type TC). (Power and Control Tray Cable) A factory assembly of two or more insulated conductors, with or without associated bare or covered equipment grounding conductors, under a nonmetallic jacket. (CMP-6)

Δ Cable, Power-Limited Tray (Type PLTC). (Power-Limited Tray Cable) A factory assembly of two or more insulated conductors rated at 300 volts, with or without associated bare or insulated equipment grounding conductors, under a nonmetallic jacket. (CMP-3)

Cable, Service. (Service Cable) Service conductors made up in the form of a cable. (CMP-10)

N Cable, Service Entrance. (Service Entrance Cable) A single conductor or multiconductor cable provided with an overall covering, primarily used for services. (CMP-6)

N Cable, Service Entrance (Type SE). Service-entrance cable having a flame-retardant, moisture-resistant covering. (CMP-6)

N Cable, Service Entrance (Type USE). Service-entrance cable, identified for underground use, having a moisture-resistant covering, but not required to have a flame-retardant covering. (CMP-6)

N Cable, Type P. A factory assembly of one or more insulated flexible tinned copper conductors, with associated equipment grounding conductor(s), with or without a braided metallic armor and with an overall nonmetallic jacket. (CMP-6)

N Cable, Under Carpet. (Under Carpet Cable) Cables that are intended to be used under carpeting, floor covering, modular tiles, and planks. (722) (CMP-3)

N Cable, Underground Feeder and Branch-Circuit (Type UF). (Underground Feeder and Branch-Circuit Cable) A factory assembly of one or more insulated conductors with an integral or an overall covering of nonmetallic material suitable for direct burial in the earth. (CMP-6)

N Cable Assembly, Flat (Type FC). (Flat Cable Assembly) An assembly of parallel conductors formed integrally with an insulating material web specifically designed for field installation in surface metal raceway. (CMP-6)

N Cable Bundle. A group of cables that are tied together or in contact with one another in a closely packed configuration for at least 1.0 m (40 in.). (CMP-3)

Informational Note: Random or loose installation of individual cables can result in less heating. Combining of the cables can result in less heat dissipation and more signal cross talk between cables.

N Cable Connector. A connector designed to join flat conductor cables (Type FCC) without using a junction box. (324) (CMP-6)

N Cable Connector [as applied to hazardous (classified) locations]. An electrical device that is part of a cable assembly and that, by insertion of two mating configurations, establishes a connection between the conductors of the cable assembly and the conductors of a fixed piece of equipment. (CMP-14)

Informational Note No. 1: See ANSI/UL 121201, *Nonincendive Electrical Equipment for Use in Class I and II, Division 2 and Class III, Divisions 1 and 2 Hazardous (Classified) Locations*, for information on the use of cable connectors.

Informational Note No. 2: Cable connectors in other than hazardous (classified) locations are referred to as male and female fittings.

Informational Note No. 3: See ANSI/UL 2238, *Cable Assemblies and Fittings for Industrial Control and Signal Distribution*, and ANSI/UL 2237, *Multi-Point Interconnection Power Cable Assemblies for Industrial Machinery*, for examples of standards on male and female fittings in other than hazardous (classified) locations.

N Cable Joint. A connection consisting of an insulation system and a connector where two (or more) medium voltage (Type MV) cables are joined together. (CMP-6)

N Cable Management System. An apparatus designed to control and organize lengths of cable or cord. (CMP-12)

Cable Routing Assembly. A single channel or connected multiple channels, as well as associated fittings, forming a structural system that is used to support and route communications wires and cables, optical fiber cables, data cables associated with information technology and communications equipment, Class 2, Class 3, and Type PLTC cables, and power-limited fire alarm cables in plenum, riser, and general-purpose applications. (CMP-16)

N Cable Sheath. A single or multiple layers of a protective covering that holds and protects the conductors or optical fibers, or both, contained inside. (CMP-16)

N Cable System, Fire-Resistive. (Fire-Resistive Cable System) A cable and components used to ensure survivability of critical circuits for a specified time under fire conditions. (CMP-3)

N Cable System, Flat Conductor. (Flat Conductor Cable System) A complete wiring system for branch circuits that is designed for installation under carpet squares. (324) (CMP-6)

Informational Note: The FCC system includes Type FCC cable and associated shielding, connectors, terminators, adapters, boxes, and receptacles.

N Cable Termination. A connection consisting of an insulation system and a connector and installed on a medium voltage (Type MV) cable to connect from a cable to a device, such as equipment. (CMP-6)

N Cable Tray System. A unit or assembly of units or sections and associated fittings forming a structural system used to securely fasten or support cables and raceways. (CMP-8)

N Cablebus. An assembly of units or sections with insulated conductors having associated fittings forming a structural system used to securely fasten or support conductors and conductor terminations in a completely enclosed, ventilated, protective metal housing. This assembly is designed to carry fault current and to withstand the magnetic forces of such current. (CMP-8)

Informational Note: Cablebus is ordinarily assembled at the point of installation from the components furnished or specified by the manufacturer in accordance with instructions for the specific job.

N Cell (as applied to batteries). The basic electrochemical unit, characterized by an anode and a cathode, used to receive, store, and deliver electrical energy. (CMP-13)

N Cell, Sealed. (Sealed Cell) A cell that has no provision for the routine addition of water or electrolyte or for external measurement of electrolyte specific gravity and might contain pressure relief venting. (CMP-13)

N Cell Line. An assembly of electrically interconnected electrolytic cells supplied by a source of direct-current power. (CMP-12)

N Cell Line Attachments and Auxiliary Equipment. A term that includes, but is not limited to, auxiliary tanks; process piping; ductwork; structural supports; exposed cell line conductors; conduits and other raceways; pumps, positioning equipment, and cell cutout or bypass electrical devices. Auxiliary equipment 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. (668) (CMP-12)

Charge Controller. Equipment that controls dc voltage or dc current, or both, and that is used to charge a battery or other energy storage device. (CMP-13)

N Charger Power Converter. The device used to convert energy from the power grid to a high-frequency output for wireless power transfer. (625) (CMP-12)

N Child Care Facility. A building or structure, or portion thereof, for educational, supervisory, or personal care services for more than four children 7 years old or less. (406) (CMP-18)

Circuit Breaker. A device designed to open and close a circuit by nonautomatic means and to open the circuit automatically on a predetermined overcurrent without damage to itself when properly applied within its rating. (CMP-10)

Informational Note: The automatic opening means can be integral, direct acting with the circuit breaker, or remote from the circuit breaker.

Circuit Breaker, Adjustable. (Adjustable Circuit Breaker) A qualifying term indicating that the circuit breaker can be set to trip at various values of current, time, or both, within a predetermined range. (CMP-10)

Circuit Breaker, Instantaneous Trip. (Instantaneous Trip Circuit Breaker) A qualifying term indicating that no delay is purposely introduced in the tripping action of the circuit breaker. (CMP-10)

Δ Circuit Breaker, Inverse Time. (Inverse Time Circuit Breaker) A qualifying term indicating that there is a delay purposely introduced in the tripping action of the circuit breaker, and the delay decreases as the magnitude of the current increases. (CMP-10)

Circuit Breaker, Nonadjustable. (Nonadjustable Circuit Breaker) A qualifying term indicating that the circuit breaker does not have any adjustment to alter the value of the current at which it will trip or the time required for its operation. (CMP-10)

• Class 1 Circuit. The portion of the wiring system between the load side of the Class 1 power source and the connected equipment. (CMP-3)

Class 2 Circuit. The portion of the wiring system between the load side of a Class 2 power source and the connected equipment.

ment. Due to its power limitations, a Class 2 circuit considers safety from a fire initiation standpoint and provides acceptable protection from electric shock. (CMP-3)

Class 3 Circuit. The portion of the wiring system between the load side of a Class 3 power source and the connected equipment. Due to its power limitations, a Class 3 circuit considers safety from a fire initiation standpoint. Since higher levels of voltage and current than for Class 2 are permitted, additional safeguards are specified to provide protection from an electric shock hazard that could be encountered. (CMP-3)

Class 4 Circuit. The portion of the wiring system between the load side of a Class 4 transmitter and the Class 4 receiver or Class 4 utilization equipment, as appropriate. Due to the active monitoring and control of the voltage and current provided, a Class 4 circuit considers safety from a fire initiation standpoint and provides acceptable protection from electric shock. (726) (CMP-3)

Informational Note: A Class 4 circuit is also commonly referred to as a fault-managed power circuit.

Class 4 Device. Any active device connected to the Class 4 circuit; examples include a Class 4 transmitter, a Class 4 receiver, or Class 4 utilization equipment. (CMP-3)

Class 4 Power System. An actively monitored and controlled system consisting of one or more Class 4 transmitters and one or more Class 4 receivers connected by a cabling system. (CMP-3)

Class 4 Receiver. A device that accepts Class 4 power and converts it for use by utilization equipment. (CMP-3)

Class 4 Transmitter. A device that sources Class 4 power. (726) (CMP-3)

Informational Note: A Class 4 transmitter is different from traditional power sources in that it monitors the line for faults (both line-to-line and line-to-ground) and ceases power transmission if a fault is sensed.

Class 4 Utilization Equipment. Devices that are directly powered by a Class 4 transmitter without the need for a separate Class 4 receiver (the receiver is integrated into the equipment). (CMP-3)

Closed Construction. Any building, building component, assembly, or system manufactured in such a manner that all concealed parts of processes of manufacture cannot be inspected after installation at the building site without disassembly, damage, or destruction. (545) (CMP-7)

Clothes Closet. A nonhabitable room or space intended primarily for storage of garments and apparel. (CMP-1)

Clothes Closet Storage Space. The area within a clothes closet in which combustible materials can be kept. (410) (CMP-18)

Collector Rings. An assembly of slip rings for transferring electric energy from a stationary to a rotating member. (675) (CMP-7)

Combiner (DC). (dc Combiner) (Direct-Current Combiner) An enclosure that includes devices used to connect two or more PV system dc circuits in parallel. (690) (CMP-4)

Combustible Dust. Solid particles that are 500 μm or smaller (i.e., material passing a U.S. No. 35 Standard Sieve as defined in ASTM E11-17, *Standard Specification for Woven Wire Test Sieve*

Cloth and Test Sieves) that can form an explosible mixture when suspended in air at standard atmospheric pressure and temperature. [499:3.3.3] (CMP-14)

Informational Note: See ASTM E1226, *Standard Test Method for Explosibility of Dust Clouds*; ISO 6184-1, *Explosion protection systems — Part 1: Determination of explosion indices of combustible dusts in air*; or ANSI/UL 80079-20-2, *Explosive Atmospheres — Part 20-2: Material Characteristics — Combustible Dusts Test Methods*, for procedures for determining the explosibility of dusts. Historically, explosibility has been described as presenting a flash fire or explosion hazard. It could be understood that potential hazards due to the formation of an explosible mixture when suspended in air at standard atmospheric pressure and temperature would include ignition.

Combustible Gas Detection System. A protection technique utilizing stationary gas detectors in industrial establishments. (CMP-14)

Commissioning. The process, procedures, and testing used to set up and verify the initial performance, operational controls, safety systems, and sequence of operation of electrical devices and equipment, prior to it being placed into active service. (CMP-13)

Communications Circuit. A metallic, fiber, or wireless circuit that provides voice/data (and associated power) for communications-related services between communications equipment. (CMP-16)

Communications Circuit, Network-Powered Broadband. (Network-Powered Broadband Communications Circuit) The circuit extending from the communications utility's or service provider's serving terminal or tap up to and including the network interface unit (NIU). (830) (CMP-16)

Informational Note: A typical one-family dwelling network-powered communications circuit consists of a communications drop or communications service cable and an NIU and includes the communications utility's serving terminal or tap where it is not under the exclusive control of the communications utility.

Communications Circuit, Premises. (Premises Communications Circuit) The circuit that extends voice, audio, video, data, interactive services, telegraph (except radio), and outside wiring for fire alarm and burglar alarm from the service provider's network terminal to the customer's communications equipment. (840) (CMP-16)

Communications Equipment. The electronic equipment that performs the telecommunications operations for the transmission of audio, video, and data, and includes power equipment (e.g., dc converters, inverters, and batteries), technical support equipment (e.g., computers), and conductors dedicated solely to the operation of the equipment. (CMP-16)

Informational Note: As the telecommunications network transitions to a more data-centric network, computers, routers, servers, and their powering equipment, are becoming essential to the transmission of audio, video, and data and are finding increasing application in communications equipment installations.

Communications Service Provider. An organization, business, or individual that offers communications service to others. (CMP-16)

Community Antenna Television Circuit (CATV). The circuit that extends community antenna television systems for audio, video, data, and interactive services from the service provider's

network terminal to the appropriate customer equipment. (CMP-16)

N Concealable Nonmetallic Extension. A listed assembly of two, three, or four insulated circuit conductors within a nonmetallic jacket, an extruded thermoplastic covering, or a sealed nonmetallic covering. The classification includes surface extensions intended for mounting directly on the surface of walls or ceilings and concealed with paint, texture, joint compound, plaster, wallpaper, tile, wall paneling, or other similar materials. (CMP-6)

Concealed. Rendered inaccessible by the structure or finish of the building. (CMP-1)

Informational Note: Wires in concealed raceways are considered concealed, even though they may become accessible by withdrawing them.

N Concealed Knob-and-Tube Wiring. A wiring method using knobs, tubes, and flexible nonmetallic tubing for the protection and support of single insulated conductors. (CMP-6)

Conductor, Bare. (Bare Conductor) A conductor having no covering or electrical insulation whatsoever. (CMP-6)

Δ Conductor, Copper-Clad Aluminum. (Copper-Clad Aluminum Conductor) Conductor drawn from a copper-clad aluminum rod, with the copper metallurgically bonded to an aluminum core. (CMP-6)

Conductor, Covered. (Covered Conductor) A conductor encased within material of composition or thickness that is not recognized by this *Code* as electrical insulation. (CMP-6)

Conductor, Insulated. (Insulated Conductor) A conductor encased within material of composition and thickness that is recognized by this *Code* as electrical insulation. (CMP-6)

N Conductor, Insulated. (Insulated Conductor) Overhead service conductor encased in a polymeric material adequate for the applied nominal voltage and any conductor types described in 310.4. (396) (CMP-6)

Informational Note: See ICEA S-76-474-2011, *Standard for Neutral Supported Power Cable Assemblies with Weather-Resistant Extruded Insulation Rated 600 Volts*, for information about overhead service conductors.

N Conductors, Outdoor Overhead. (Outdoor Overhead Conductors) Single conductors, insulated, covered, or bare, installed outdoors on support structures in free air. (399) (CMP-6)

N Conduit, Flexible Metal (FMC). (Flexible Metal Conduit) A raceway of circular cross section made of helically wound, formed, interlocked metal strip. (CMP-8)

N Conduit, High Density Polyethylene (HDPE). (High Density Polyethylene Conduit) A nonmetallic raceway of circular cross section, with associated couplings, connectors, and fittings for the installation of electrical conductors. (CMP-8)

N Conduit, Intermediate Metal (IMC). (Intermediate Metal Conduit) A steel threadable raceway of circular cross section designed for the physical protection and routing of conductors and cables and for use as an equipment grounding conductor when installed with its integral or associated coupling and appropriate fittings. (CMP-8)

N Conduit, Liquidtight Flexible Metal (LFMC). (Liquidtight Flexible Metal Conduit) A raceway of circular cross section having

an outer liquidtight, nonmetallic, sunlight-resistant jacket over an inner flexible metal core with associated couplings, connectors, and fittings for the installation of electric conductors. (CMP-8)

N Conduit, Liquidtight Flexible Nonmetallic (LFNC). (Liquidtight Flexible Nonmetallic Conduit) A raceway of circular cross section of various types as follows:

- (1) A smooth seamless inner core and cover bonded together and having one or more reinforcement layers between the core and covers, designated as LFNC-A
- (2) A smooth inner surface with integral reinforcement within the raceway wall, designated as LFNC-B
- (3) A corrugated internal and external surface without integral reinforcement within the raceway wall, designated as LFNC-C

(CMP-8)

Informational Note: FNMC is an alternative designation for LFNC.

N Conduit, Nonmetallic Underground with Conductors (NUCC). (Nonmetallic Underground Conduit with Conductors) A factory assembly of conductors or cables inside a nonmetallic, smooth wall raceway with a circular cross section. (CMP-8)

N Conduit, Reinforced Thermosetting Resin (RTRC). (Reinforced Thermosetting Resin Conduit) A rigid nonmetallic raceway of circular cross section, with integral or associated couplings, connectors, and fittings for the installation of electrical conductors and cables. (CMP-8)

N Conduit, Rigid Metal (RMC). (Rigid Metal Conduit) A threadable raceway of circular cross section designed for the physical protection and routing of conductors and cables and for use as an equipment grounding conductor when installed with its integral or associated coupling and appropriate fittings. (CMP-8)

N Conduit, Rigid Polyvinyl Chloride (PVC). (Rigid Polyvinyl Chloride Conduit) A rigid nonmetallic raceway of circular cross section, with integral or associated couplings, connectors, and fittings for the installation of electrical conductors and cables. (CMP-8)

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. (CMP-9)

N Connector. An electromechanical fitting. (393) (CMP-18)

N Connector, Intercell. (Intercell Connector) An electrically conductive bar or cable used to connect adjacent cells. (CMP-13)

N Connector, Intertier. (Intertier Connector) An electrical conductor used to connect two cells on different tiers of the same rack or different shelves of the same rack. (CMP-13)

N Connector, Load. (Load Connector) An electromechanical connector used for power from the busbar to utilization equipment. (393) (CMP-18)

N Connector, Pendant. (Pendant Connector) An electromechanical or mechanical connector used to suspend low-voltage luminaire or utilization equipment below the grid rail and to

supply power to connect from the busbar to utilization equipment. (393) (CMP-18)

N Connector, Power Feed. (Power Feed Connector) An electro-mechanical connector used to connect the power supply to a power distribution cable, to connect directly to the busbar, or to connect from a power distribution cable to the busbar. (393) (CMP-18)

Connector, Pressure (Solderless). (Pressure Connector) A device that establishes a connection between two or more conductors or between one or more conductors and a terminal by means of mechanical pressure and without the use of solder. (CMP-1)

N Connector, Rail to Rail. (Rail to Rail Connector) An electro-mechanical connector used to interconnect busbars from one ceiling grid rail to another grid rail. (393) (CMP-18)

N Connector Strip. A metal wireway containing pendant or flush receptacles. (520) (CMP-15)

N Container (as applied to batteries). A single-cell or multicell vessel or jar that holds the plates, electrolyte, and other elements of a single unit in a battery. (CMP-13)

Continuous Load. A load where the maximum current is expected to continue for 3 hours or more. (CMP-2)

N Control. The predetermined process of connecting, disconnecting, increasing, or reducing electric power. (750) (CMP-13)

Control Circuit. The circuit of a control apparatus or system that carries the electric signals directing the performance of the controller but does not carry the main power current. (CMP-11)

N Control Circuits, Fault-Tolerant External. (Fault-Tolerant External Control Circuits) Those control circuits either entering or leaving the fire pump controller enclosure, which if broken, disconnected, or shorted will not prevent the controller from starting the fire pump from all other internal or external means and may cause the controller to start the pump under these conditions. (695) (CMP-13)

N Control Device, Emergency Lighting. (Emergency Lighting Control Device) A separate or integral device intended to perform one or more emergency lighting control functions. (700) (CMP-13)

Informational Note: See UL 924, *Emergency Lighting and Power Equipment*, for information covering emergency lighting control devices.

Control Drawing. A drawing or other document provided by the manufacturer of the intrinsically safe or associated apparatus, or of the nonincendive field wiring apparatus or associated nonincendive field wiring apparatus, that details the allowed interconnections between the intrinsically safe and associated apparatus or between the nonincendive field wiring apparatus or associated nonincendive field wiring apparatus. (CMP-14)

Informational Note: See the following standards for additional information:

- (1) ANSI/ISA/UL 120202, *Recommendations for the Preparation, Content, and Organization of Intrinsic Safety Control Drawings*
- (2) ANSI/UL 913, *Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations*

- (3) ANSI/UL 60079-11, *Explosive Atmospheres — Part 11: Equipment Protection by Intrinsic Safety “i”*
- (4) ANSI/UL 121201, *Nonincendive Electrical Equipment for Use in Class I and II, Division 2 and Class III, Divisions 1 and 2 Hazardous (Classified) Locations*
- (5) ANSI/ISA RP 12.06.01, *Recommended Practice for Wiring Methods for Hazardous (Classified) Locations Instrumentation — Part 1: Intrinsic Safety*

N Control Room. An enclosed control space outside the hoistway, intended for full bodily entry, that contains the elevator motor controller. The room could also contain electrical and/or mechanical equipment used directly in connection with the elevator or dumbwaiter but not the electric driving machine or the hydraulic machine. (620) (CMP-12)

N Control Space. A space inside or outside the hoistway intended to be accessed with or without full bodily entry that contains the elevator motor controller. This space could also contain electrical and/or mechanical equipment used directly in connection with the elevator, dumbwaiter, escalator, moving walk, or platform lift, but not the electrical driving machine or the hydraulic machine. (620) (CMP-12)

N Control System. The overall system governing the starting, stopping, direction of motion, acceleration, speed, and retardation of the moving member. (620) (CMP-12)

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. (CMP-1)

N Controller, Motion. (Motion Controller) The electrical device(s) for that part of the control system that governs the acceleration, speed, retardation, and stopping of the moving member. (620) (CMP-12)

Informational Note: The motor control function may be integral to the motion controller.

N Controller, Motor. (Motor Controller) Any switch or device that is normally used to start and stop a motor by making and breaking the motor circuit current. (CMP-11)

N Controller, Operation. (Operation Controller) The electrical device(s) for that part of the control system that initiates the starting, stopping, and direction of motion in response to a signal from an operating device. (620) (CMP-12)

Converter, DC-to-DC. (DC-to-DC Converter) A device that can provide an output dc voltage and current at a higher or lower value than the input dc voltage and current. (CMP-4)

N Converter Circuit, DC-to-DC. (DC-to-DC Converter Circuit) The dc circuit conductors connected to the output of a dc-to-dc converter. (CMP-4)

N Converting Device. That part of the heating equipment that converts input mechanical or electrical energy to the voltage, current, and frequency used for the heating applicator. A converting device consists of equipment using line frequency, all static multipliers, oscillator-type units using vacuum tubes, inverters using solid-state devices, or motor-generator equipment. (665) (CMP-12)

Cooking Unit, Counter-Mounted. (Counter-Mounted Cooking Unit) 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 mountable controls. (CMP-2)

Δ Coordination, Selective. (Selective Coordination) Localization of an overcurrent condition to restrict outages to the circuit or equipment affected, accomplished by the selection and installation of overcurrent protective devices and their ratings or settings for the full range of available overcurrents, from overload to the available fault current, and for the full range of overcurrent protective device opening times associated with those overcurrents. (CMP-10)

N Cord, Flexible. (Flexible Cord) Two or more flexible insulated conductors enclosed in a flexible covering. (CMP-6)

N Cord Connector. A contact device terminated to a flexible cord that accepts an attachment plug or other insertion device. (CMP-6)

Cord Connector [as applied to hazardous (classified) locations]. A fitting intended to terminate a cord to a box or similar device and reduce the strain at points of termination and might include an explosionproof, a dust-ignitionproof, or a flameproof seal. (CMP-14)

N Cord Set. A length of flexible cord having an attachment plug at one end and a cord connector at the other end. (CMP-6)

N Corrosive Environment. Areas or enclosures without adequate ventilation, where electrical equipment is located and pool sanitation chemicals are stored, handled, or dispensed. (680) (CMP-17).

Informational Note No. 1: See *Advisory: Swimming Pool Chemical: Chlorine*, OSWER 90-008.1, June 1990, available from the EPA National Service Center for Environmental Publications (NSCEP) as sanitation chemicals and pool water are considered to pose a risk of corrosion (gradual damage or destruction of materials) due to the presence of oxidizers (e.g., calcium hypochlorite, sodium hypochlorite, bromine, chlorinated isocyanurates) and chlorinating agents that release chlorine when dissolved in water.

Informational Note No. 2: See ANSI/APSP-11, *Standard for Water Quality in Public Pools and Spas*, ANSI/ASHRAE 62.1, Table 6-4 Minimum Exhaust Rates, and 2021 *International Swimming Pool and Spa Code (ISPSC)*, Section 324, including associated definitions and requirements concerning adequate ventilation of indoor spaces such as equipment and chemical storage rooms, which can reduce the likelihood of the accumulation of corrosive vapors. Chemicals such as chlorine cause severe corrosive and deteriorating effects on electrical connections, equipment, and enclosures when stored and kept in the same vicinity.

N Counter (Countertop). A fixed or stationary surface typically intended for food preparation and serving, personal lavation, or laundering or a similar surface that presents a routine risk of spillage of larger quantities of liquids upon outlets mounted directly on or in the surface. (CMP-2)

Informational Note No. 1: See UL 498, *Receptacles and Attachment Plugs*, and UL 943, *Ground-Fault Circuit Interrupters*, which establish the performance evaluation criteria and construction criteria.

Informational Note No. 2: See 406.5(E), 406.5(G)(1), and 406.5(H) for information on receptacles for counters and countertops distinguished from receptacles for work surfaces.

N Crane. A mechanical device used for lifting or moving boats. [303:3.3.6] (555) (CMP-7)

N Critical Branch. A system of feeders and branch circuits supplying power for task illumination, fixed equipment, select receptacles, and select power circuits serving areas and functions

related to patient care that are automatically connected to alternate power sources by one or more transfer switches during interruption of the normal power source. [99:3.3.30] (517) (CMP-15)

N Critical Operations Areas, Designated (DCOA). (Designated Critical Operations Areas) Areas within a facility or site designated as requiring critical operations power. (CMP-13)

N Critical Operations Data System. An information technology equipment system that requires continuous operation for reasons of public safety, emergency management, national security, or business continuity. (645) (CMP-12)

N Critical Operations Power Systems (COPS). Power systems for facilities or parts of facilities that require continuous operation for the reasons of public safety, emergency management, national security, or business continuity. (CMP-13)

Cutout Box. An enclosure designed for surface mounting that has swinging doors or covers secured directly to and telescoping with the walls of the enclosure. (CMP-9)

N Data Center, Modular (MDC). (Modular Data Center) Prefabricated units, rated 1000 volts or less, consisting of an outer enclosure housing multiple racks or cabinets of information technology equipment (ITE) (e.g., servers) and various support equipment, such as electrical service and distribution equipment, HVAC systems, and the like. (646) (CMP-12)

Informational Note: A typical construction may use a standard ISO shipping container or other structure as the outer enclosure, racks or cabinets of ITE, service-entrance equipment and power distribution components, power storage such as a UPS, and an air or liquid cooling system. Modular data centers are intended for fixed installation, either indoors or outdoors, based on their construction and resistance to environmental conditions. MDCs can be configured as an all-in-one system housed in a single equipment enclosure or as a system with the support equipment housed in separate equipment enclosures.

N DC Plugging Box. A dc device consisting of one or more 2-pole, 2-wire, nonpolarized, non-grounding-type receptacles intended to be used on dc circuits only. (530) (CMP-15)

Dead-Front. Without live parts exposed to a person on the operating side of the equipment. (CMP-9)

Demand Factor. The ratio of the maximum demand of a system, or part of a system, to the total connected load of a system or the part of the system under consideration. (CMP-2)

N Dental Office. A building or part thereof in which the following occur:

- (1) Examinations and minor treatments/procedures performed under the continuous supervision of a dental professional;
- (2) Use of limited to minimal sedation and treatment or procedures that do not render the patient incapable of self-preservation under emergency conditions; and
- (3) No overnight stays for patients or 24-hour operations. [99:3.3.38] (CMP-15)

Device. A unit of an electrical system, other than a conductor, that carries or controls electric energy as its principal function. (CMP-1)

N Dielectric Heating. Heating of a nominally insulating material due to its own dielectric losses when the material is placed in a varying electric field. (665) (CMP-12)

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. (CMP-1)

N Distribution Point (Center Yard Pole) (Meter Pole). An electrical supply point from which service drops, service conductors, feeders, or branch circuits to buildings or structures utilized under single management are supplied. (547) (CMP-7)

Informational Note: The service point is typically located at the distribution point.

N Diversion Controller (Diversion Charge Controller) (Diversion Load Controller). Equipment that regulates the output of a source or charging process by diverting power to direct-current or alternating-current loads or to an interconnected utility service. (CMP-13)

N Diversion Load. A load connected to a diversion charge controller or diversion load controller, also known as a dump load. (CMP-4)

N Docking Facility. A covered or open, fixed or floating structure that provides access to the water and to which boats are secured. [303:3.3.7] (555) (CMP-7)

Dormitory Unit. A building or a space in a building in which group sleeping accommodations are provided for more than 16 persons who are not members of the same family in one room, or a series of closely associated rooms, under joint occupancy and single management, with or without meals, but without individual cooking facilities. (CMP 2)

N Drop Box. A box containing pendant- or flush-mounted receptacles attached to a multiconductor cable via strain relief or a multipole connector. (520) (CMP-15)

Δ Dust-Ignitionproof. Equipment enclosed in a manner that excludes dusts and does not permit arcs, sparks, or heat otherwise generated or liberated inside of the enclosure to cause ignition of exterior accumulations or atmospheric suspensions of a specified dust on or in the vicinity of the enclosure. (CMP-14)

Informational Note No. 1: See ANSI/UL 1203, *Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations*, for additional information on dust-ignitionproof enclosures.

Informational Note No. 2: See NEMA 250, *Enclosures for Electrical Equipment (1000 Volts Maximum)*, for additional information on dust-ignitionproof enclosures that are sometimes marked additionally marked Type 9.

Δ Dusttight. Enclosures constructed so that dust will not enter under specified test conditions. (CMP-14)

Informational Note No. 1: See ANSI/UL 121201, *Nonincendive Electrical Equipment for Use in Class I and II, Division 2 and Class III, Divisions 1 and 2 Hazardous (Classified) Locations*, for additional information.

Informational Note No. 2: See NEMA 250, *Enclosures for Electrical Equipment (1000 Volts Maximum)*, and ANSI/UL 50E, *Enclosures for Electrical Equipment, Environmental Considerations*, for additional information on enclosure Types 3, 3X, 3S, 3SX, 4, 4X, 5, 6, 6P, 12, 12K, and 13 that are considered dusttight.

Duty, Continuous. (Continuous Duty) Operation at a substantially constant load for an indefinitely long time. (CMP-1)

Duty, Intermittent. (Intermittent Duty) Operation for alternate intervals of (1) load and no load; or (2) load and rest; or (3) load, no load, and rest. (CMP-1)

Duty, Periodic. (Periodic Duty) Intermittent operation in which the load conditions are regularly recurrent. (CMP-1)

Duty, Short-Time. (Short-Time Duty) Operation at a substantially constant load for a short and definite, specified time. (CMP-1)

Duty, Varying. (Varying Duty) Operation at loads, and for intervals of time, both of which may be subject to wide variation. (CMP-1)

Dwelling, One-Family. (One-Family Dwelling) A building that consists solely of one dwelling unit. (CMP-1)

Dwelling, Two-Family. (Two-Family Dwelling) A building that consists solely of two dwelling units. (CMP-1)

Dwelling, Multifamily. (Multifamily Dwelling) A building that contains three or more dwelling units. (CMP-1)

Dwelling Unit. A single unit, providing complete and independent living facilities for one or more persons, including permanent provisions for living, sleeping, cooking, and sanitation. (CMP-2)

Electric-Discharge Lighting. Systems of illumination utilizing fluorescent lamps, high-intensity discharge (HID) lamps, or neon tubing. (CMP-18)

Electric Power Production and Distribution Network. Power production, distribution, and utilization equipment and facilities, such as electric utility systems that are connected to premises wiring and are external to and not controlled by a system that operates in interactive mode. (CMP-13)

Electric Sign. A fixed, stationary, or portable self-contained, electrically operated and/or electrically illuminated utilization equipment with words or symbols designed to convey information or attract attention. (CMP-18)

N Electric Supply Stations. Locations containing the generating stations and substations, including their associated generator, storage battery, transformer, and switchgear areas. (CMP-4)

Δ Electric Vehicle (EV). An automotive-type vehicle for on-road use, such as passenger automobiles, buses, trucks, vans, neighborhood electric vehicles, and electric motorcycles, primarily powered by an electric motor that draws current from a rechargeable storage battery, fuel cell, photovoltaic array, or other source of electric current. Plug-in hybrid electric vehicles (PHEV) are electric vehicles having a second source of motive power. (CMP-12)

Informational Note: Off-road, self-propelled electric mobile machines, such as industrial trucks, hoists, lifts, transports, golf carts, airline ground support equipment, tractors, and boats are not considered electric vehicles.

N Electric Vehicle Connector. A device that, when electrically coupled (conductive or inductive) to an electric vehicle inlet, establishes an electrical connection to the electric vehicle for the purpose of power transfer and information exchange. (625) (CMP-12)

Informational Note: See 625.48 for further information on interactive systems.

N Electric Vehicle Power Export Equipment (EVPE). The equipment, including the outlet on the vehicle, that is used to provide electrical power at voltages greater than or equal to 30 Vac or 60 Vdc to loads external to the vehicle, using the vehicle as the source of supply. (625) (CMP-12)

Informational Note: Electric vehicle power export equipment and electric vehicle supply equipment or wireless power transfer equipment are sometimes contained in one piece of equipment, sometimes referred to as a bidirectional electric vehicle supply equipment (EVSE) or bidirectional wireless power transfer equipment (WPTE).

N Electric Vehicle Supply Equipment (EVSE). Equipment for plug-in charging, including the ungrounded, grounded, and equipment grounding conductors, and the electric vehicle connectors, attachment plugs, personnel protection system, and all other fittings, devices, power outlets, or apparatus installed specifically for the purpose of transferring energy between the premises wiring and the electric vehicle. (625) (CMP-12)

Informational Note: Electric vehicle power export equipment and electric vehicle supply equipment or wireless power transfer equipment (WPTE) are sometimes contained in one piece of equipment, sometimes referred to as a bidirectional EVSE or bidirectional WPTE.

Electrical Circuit Protective System. A system consisting of components and materials intended for installation as protection for specific electrical wiring systems with respect to the disruption of electrical circuit integrity upon exterior fire exposure. (CMP-16)

N Electrical Datum Plane. A specified vertical distance above the normal high-water level at which electrical equipment can be installed and electrical connections can be made. (CMP-7)

N Electrical Ducts. Electrical conduits, or other raceways round in cross section, that are suitable for use underground or embedded in concrete. (CMP-6)

N Electrical Life Support Equipment. Electrically powered equipment whose continuous operation is necessary to maintain a patient's life. [99:3.3.45] (517) (CMP-15)

Δ Electrical Resistance Trace Heating “60079-30-1”. Type of protection for the purpose of producing heat on the principle of electrical resistance and typically composed of one or more metallic conductors and/or an electrically conductive material, suitably electrically insulated and protected. (CMP-14)

Informational Note: See ANSI/UL 60079-30-1, *Explosive Atmospheres — Part 30-1: Electrical Resistance Trace Heating — General and Testing Requirements*, for additional information.

N Electrically Connected. A connection capable of carrying current as distinguished from connection through electromagnetic induction. (668) (CMP-12)

N Electrified Truck Parking Space. A truck parking space that has been provided with an electrical system that allows truck operators to connect their vehicles while stopped and to use off-board power sources in order to operate on-board systems such as air conditioning, heating, and appliances, without any engine idling. (626) (CMP-12)

Informational Note: An electrified truck parking space also includes dedicated parking areas for heavy-duty trucks at travel plazas, warehouses, shipper and consignee yards, depot facilities, and border crossings. It does not include areas such as the

shoulders of highway ramps and access roads, camping and recreational vehicle sites, residential and commercial parking areas used for automotive parking or other areas where ac power is provided solely for the purpose of connecting automotive and other light electrical loads, such as engine block heaters, and at private residences.

N Electrified Truck Parking Space Wiring Systems. All of the electrical wiring, equipment, and appurtenances related to electrical installations within an electrified truck parking space, including the electrified parking space supply equipment. (626) (CMP-12)

N Electrolyte. The medium that provides the ion transport mechanism between the positive and negative electrodes of a cell. (CMP-13)

N Electrolytic Cell. A tank or vat in which electrochemical reactions are caused by applying electric energy for the purpose of refining or producing usable materials. (668) (CMP-12)

N Electrolytic Cell Line Working Zone. The space envelope wherein operation or maintenance is normally performed on or in the vicinity of exposed energized surfaces of electrolytic cell lines or their attachments. (668) (CMP-12)

N Electronic Power Converter. A device that uses power electronics to convert one form of electrical power into another form of electrical power. (CMP-4)

Informational Note: Examples of electronic power converters include, but are not limited to, inverters, dc-to-dc converters, and electronic charge controllers. These devices have limited current capabilities based on the device ratings at continuous rated power.

N Electronically Protected. A motor provided with electronic control that is an integral part of the motor and protects the motor against dangerous overheating due to failure of the electronic control, overload, and failure to start. (430) (CMP-11)

N Emergency Luminaire, Battery-Equipped. (Battery-Equipped Emergency Luminaire) A luminaire with a rechargeable battery, a battery charging means, and an automatic load control relay. (CMP-13)

N Emergency Luminaire, Directly Controlled. (Directly Controlled Emergency Luminaire) A luminaire supplied by the facility emergency power system and with a control input for dimming or switching that provides an emergency illumination level upon loss of normal power. (700) (CMP-13)

Informational Note: See ANSI/UL 924, *Emergency Lighting and Power Equipment*, for information covering directly controlled emergency luminaires.

N Emergency Power Supply (EPS). The source(s) of electric power of the required capacity and quality for an emergency power supply system (EPSS). (CMP-13)

N Emergency Power Supply System (EPSS). A complete functioning EPS system coupled to a system of conductors, disconnecting means and overcurrent protective devices, transfer switches, and all control, supervisory, and support devices up to and including the load terminals of the transfer equipment needed for the system to operate as a safe and reliable source of electric power. [110:3.3.4] (CMP-13)

N Emergency Systems. Those systems legally required and classed as emergency by municipal, state, federal, or other codes, or by any governmental agency having jurisdiction.

These systems are intended to automatically supply illumination, power, or both, to designated areas and equipment in the event of failure of the normal supply or in the event of accident to elements of a system intended to supply, distribute, and control power and illumination essential for safety to human life. (CMP-13)

Δ Encapsulation “m”. Type of protection where electrical parts that could ignite an explosive atmosphere by either sparking or heating are enclosed in a compound in such a way that this explosive atmosphere cannot be ignited. (CMP-14)

Informational Note: See ANSI/UL 60079-18, *Explosive atmospheres — Part 18: Equipment protection by encapsulation “m”*, for additional information.

Enclosed. Surrounded by a case, housing, fence, or wall(s) that prevents persons from accidentally contacting energized parts. (CMP-1)

N Enclosed-Break. Having electrical make-or-break contacts such that, if an internal explosion of the flammable gas or vapor that can enter it occurs, the device will withstand the internal explosion without suffering damage and without communicating the internal explosion to the external flammable gas or vapor. (CMP-14)

Informational Note: See ANSI/UL 121201, *Nonincendive Electrical Equipment for Use in Class I and II, Division 2 and Class III, Divisions 1 and 2 Hazardous (Classified) Locations*, for additional information.

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. (CMP-1)

Informational Note: See Table 110.28 for examples of enclosure types.

Energized. Electrically connected to, or is, a source of voltage. (CMP-1)

N Energized, Likely to Become. (Likely to Become Energized) Conductive material that could become energized because of the failure of electrical insulation or electrical spacing. (CMP-5)

N Energy Management System (EMS). A system consisting of any of the following: a monitor(s), communications equipment, a controller(s), a timer(s), or other device(s) that monitors and/or controls an electrical load or a power production or storage source. (CMP-13)

N Energy Storage System (ESS). One or more devices installed as a system capable of storing energy and providing electrical energy into the premises wiring system or an electric power production and distribution network. (CMP-13)

Informational Note No. 1: An ESS(s) can include but is not limited to batteries, capacitors, and kinetic energy devices (e.g., flywheels and compressed air). An ESS(s) can include inverters or converters to change voltage levels or to make a change between an ac or a dc system.

Informational Note No. 2: These systems differ from a stationary standby battery installation where a battery spends the majority of the time on continuous float charge or in a high state of charge, in readiness for a discharge event.

N Entertainment Device. A mechanical or electromechanical device that provides an entertainment experience. (522) (CMP-15)

Informational Note: These devices can include animated props, show action equipment, animated figures, and special effects, coordinated with audio and lighting to provide an entertainment experience.

Equipment. A general term, including fittings, devices, appliances, luminaires, apparatus, machinery, and the like used as a part of, or in connection with, an electrical installation. (CMP-1)

Equipment, Mobile. (Mobile Equipment) Equipment with electrical components that is suitable to be moved only with mechanical aids or is provided with wheels for movement by a person(s) or powered devices. (513) (CMP-14)

N Equipment, Portable. (Portable Equipment) Equipment fed with portable cords or cables intended to be moved from one place to another. (640) (CMP-12)

Equipment, Portable. (Portable Equipment) Equipment with electrical components suitable to be moved by a single person without mechanical aids. (511) (CMP-14)

N Equipment, Portable. (Portable Equipment) Equipment fed with portable cords or cables intended to be moved from one place to another. (520) (CMP-15)

N Equipment, Portable. (Portable Equipment) Equipment intended to be moved from one place to another. (530) (CMP-15)

N Equipment, Signal. (Signal Equipment) Includes audible and visual equipment such as chimes, gongs, lights, and displays that convey information to the user. (620) (CMP-12)

N Equipment Branch. A system of feeders and branch circuits arranged for delayed, automatic, or manual connection to the alternate power source and that serves primarily 3-phase power equipment. [99:3.3.50] (517) (CMP-15)

N Equipment Protection Level (EPL). Level of protection assigned to equipment based on its likelihood of becoming a source of ignition, and distinguishing the differences between explosive gas atmospheres and explosive dust atmospheres. (CMP-14)

Informational Note: See ANSI/UL 60079-0, *Explosive Atmospheres — Part 0: Equipment — General Requirements*, for additional information.

N Equipment Rack. A framework for the support, enclosure, or both, of equipment; can be portable or stationary. (640) (CMP-12)

Informational Note: See EIA/ECA 310-E-2005, *Cabinets, Racks, Panels and Associated Equipment*, for examples of equipment racks.

Equipotential Plane. Conductive parts bonded together to reduce voltage gradients in a designated area. (682) (CMP-17)

N Equipotential Plane. Conductive elements that are connected together to minimize voltage differences. (CMP-7)

N Essential Electrical System. A system comprised of alternate power sources and all connected distribution systems and ancillary equipment, designed to ensure continuity of electrical power to designated areas and functions of a health care facility during disruption of normal power sources, and also to mini-

mize disruption within the internal wiring system. [99:3.3.52] (517) (CMP-15)

Δ Explosionproof Equipment. Equipment enclosed in a case that is capable of withstanding an explosion of a specified gas or vapor that **might** occur within it, **that is capable** of preventing the ignition of a specified gas or vapor surrounding the enclosure by sparks, flashes, or explosion of the gas or vapor within, and that operates at such an external temperature that a surrounding flammable atmosphere will not be ignited. (CMP-14)

Informational Note No. 1: See ANSI/UL 1203, *Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations*, for additional information.

Informational Note No. 2: See NEMA 250, *Enclosures for Electrical Equipment (1000 Volts Maximum)*, for additional information on explosionproof enclosures that are sometimes additionally marked Type 7.

Exposed (as applied to live parts). Capable of being inadvertently touched or approached nearer than a safe distance by a person. (CMP-1)

Informational Note: This term applies to parts that are not suitably guarded, isolated, or insulated.

Exposed (as applied to wiring methods). On or attached to the surface or behind panels designed to allow access. (CMP-1)

N Exposed (Optical Fiber Cable Exposed to Accidental Contact). A conductive optical fiber cable in such a position that, in case of failure of supports or insulation, contact between the cable's non-current-carrying conductive members and an electrical circuit might result. (CMP-16)

N Exposed (to Accidental Contact). A circuit in such a position that, in case of failure of supports or insulation, contact with another circuit may result. (CMP-16)

N Exposed Conductive Surfaces. Those surfaces that are capable of carrying electric current and that are unprotected, uninsulated, unenclosed, or unguarded, permitting personal contact. [99:3.3.54] (517) (CMP-15)

Informational Note: Paint, anodizing, and similar coatings are not considered suitable insulation, unless they are listed for such use.

Externally Operable. Capable of being operated without exposing the operator to contact with live parts. (CMP-1)

N Facility, On-Site Power Production. (On-Site Power Production Facility) The normal supply of electric power for the site that is expected to be constantly producing power. (695) (CMP-13)

N Fastened-in-Place. Mounting means of equipment in which the fastening means are specifically designed to permit removal without the use of a tool. (625) (CMP-12)

N Fault-Managed Power (FMP). A powering system that monitors for faults and controls current delivered to ensure fault energy is limited. (726) (CMP-3)

Informational Note No. 1: The monitoring and control systems differentiate fault-managed power from electric light and power circuits; therefore, alternative requirements to those of Chapters 1 through 4 are given regarding minimum wire sizes, ampacity adjustment and correction factors, overcurrent protection, insulation requirements, and wiring methods and materials.

Informational Note No. 2: A fault-managed power circuit is also commonly referred to as a Class 4 circuit.

Fault Current. The current delivered at a point on the system during a short-circuit condition. (CMP-10)

Δ Fault Current, Available. (Available Fault Current) The largest amount of current capable of being delivered at a point on the system during a short-circuit condition. (CMP-10)

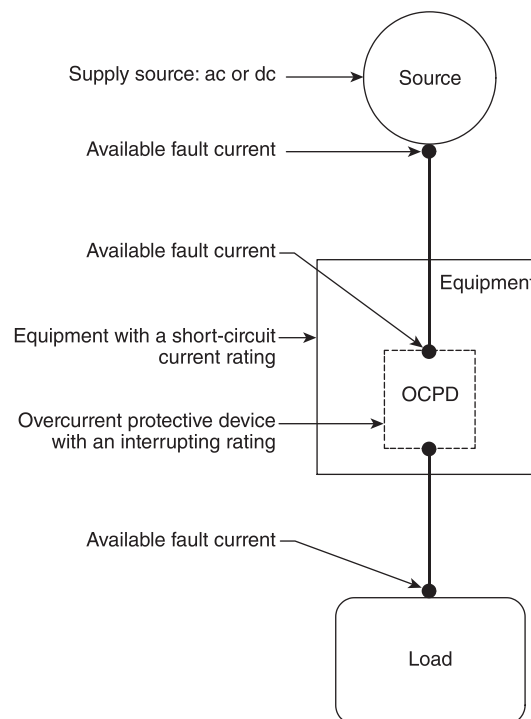
Informational Note: A short-circuit can occur during abnormal conditions such as a fault between circuit conductors or a ground fault. See Informational Note Figure 100.1.

N Fault Protection Device. An electronic device that is intended for the protection of personnel and functions under fault conditions, such as network-powered broadband communications cable short or open circuit, to limit the current or voltage, or both, for a low-power network-powered broadband communications circuit and provide acceptable protection from electric shock. (830) (CMP-16)

Feeder. All circuit conductors between the service equipment, the source of a separately derived system, or other power supply source and the final branch-circuit overcurrent device. (CMP-10)

N Feeder Assembly. The overhead or under-chassis feeder conductors, including the equipment grounding conductor, together with the necessary fittings and equipment; or the power-supply cord assembly for a mobile home, recreational vehicle, or park trailer, identified for the delivery of energy from the source of electrical supply to the panelboard within the mobile home, recreational vehicle, or park trailer. (CMP-7)

Festoon Lighting. A string of outdoor lights that is suspended between two points. (CMP-18)



Informational Note Figure 100.1 Available Fault Current.

Δ Fibers/Flyings, Combustible. (Combustible Fibers/Flyings)

Fibers/flyings, where any dimension is greater than 500 μm in nominal size, which can form an explosible mixture when suspended in air at standard atmospheric pressure and temperature. [499:3.3.4.1] (CMP-14)

Informational Note No. 1: This definition and Informational Notes No. 2 and No. 3 have been extracted from NFPA 499-2021, *Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas*. The NFPA 499 reference is in brackets. Only editorial changes were made to the extracted text to make it consistent with this *Code*.

Informational Note No. 2: Section 500.5(D) defines a Class III location. Combustible fibers/flyings can be similar in physical form to ignitable fibers/flyings and protected using the same electrical equipment installation methods. Examples of fibers/flyings include flat platelet-shaped particulate, such as metal flake, and fibrous particulate, such as particle board core material. If the smallest dimension of a combustible material is greater than 500 μm , it is unlikely that the material would be combustible fibers/flyings, as determined by test. Finely divided solids with lengths that are large compared to their diameter or thickness usually do not pass through a 500 μm sieve, yet when tested could potentially be determined to be explosible. [499:A.3.3.4.1]

Informational Note No. 3: See ASTM E1226, *Standard Test Method for Explosibility of Dust Clouds*, ISO 6184-1, *Explosion protection systems — Part 1: Determination of explosion indices of combustible dusts in air*, or ISO/IEC/UL 80079-20-2, *Explosive atmospheres — Part 20-2: Material characteristics — Combustible dusts test methods*, for procedures for determining the explosibility of dusts. A material that is found to not present an explosible mixture could still be an ignitable fiber/flying, as defined in this article. Historically, the explosibility condition has been described as presenting a flash fire or explosion hazard. It could be understood that the potential hazard due to the formation of an explosible mixture when suspended in air at standard atmospheric pressure and temperature would include ignition. [499:A.3.3.4.1]

Fibers/Flyings, Ignitable. (Ignitable Fibers/Flyings) Fibers/flyings where any dimension is greater than 500 μm in nominal size, which are not likely to be in suspension in quantities to produce an explosible mixture, but could produce an ignitable layer fire hazard. [499:3.3.4.2] (CMP-14)

Informational Note No. 1: This definition and Informational Note No. 2 have been extracted from NFPA 499-2021, *Recommended Practice for the Classification of Combustible Dusts and of Hazardous (Classified) Locations for Electrical Installations in Chemical Process Areas*. The NFPA 499 reference is in brackets. Only editorial changes were made to the extracted text to make it consistent with this *Code*.

Informational Note No. 2: Section 500.5 of this *Code* prescribes a Class III location as one where ignitable fibers/flyings are present, but not likely to be in suspension in the air in quantities sufficient to produce ignitable mixtures. This description addresses fibers/flyings that do not present a flash-fire hazard or explosion hazard by test. This could be because those fibers/flyings are too large or too agglomerated to be suspended in air in sufficient concentration, or at all, under typical test conditions. Alternatively, this could be because they burn so slowly that, when suspended in air, they do not propagate combustion at any concentration. In this document the zone classification system includes ignitable fibers/flyings as a fire hazard in a layer, which is not addressed in the IEC zone system (see IEC 60079-10-2, *Explosive atmospheres — Part 10-2: Classification of areas — Explosive dust atmospheres*). Where these are present, the user

could also consider installation in accordance with Article 503 of this *Code*. [499:A.3.3.4.2]

Field Evaluation Body (FEB). An organization or part of an organization that performs field evaluations of electrical or other equipment. [790:3.3.4] (CMP-1)

Informational Note: See NFPA 790-2021, *Standard for Competency of Third-Party Field Evaluation Bodies*, provides guidelines for establishing the qualification and competency of a body performing field evaluations of electrical products and assemblies with electrical components.

Field Labeled (as applied to evaluated products). Equipment or materials to which has been attached a label, symbol, or other identifying mark of an FEB indicating the equipment or materials were evaluated and found to comply with requirements as described in an accompanying field evaluation report. [790:3.3.6] (CMP-1)

N Fire Alarm Circuit. The portion of the wiring system between the load side of the overcurrent device or the power-limited supply and the connected equipment of all circuits powered and controlled by the fire alarm system. Fire alarm circuits are classified as either non-power-limited or power-limited. (CMP-3)

N Fire Alarm Circuit, Non-Power-Limited (NPLFA). (Non-Power-Limited Fire Alarm Circuit) A fire alarm circuit powered by a source that is not power limited. (CMP-3)

Informational Note: See 760.41 and 760.43 for requirements for non-power-limited fire alarm circuits.

N Fire Alarm Circuit, Power-Limited (PLFA). (Power-Limited Fire Alarm Circuit) A fire alarm circuit powered by a power-limited source. (CMP-3)

Informational Note: See 760.121 for requirements on power-limited fire alarm circuits.

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. (CMP-1)

N Fixed (as applied to equipment). Equipment that is fastened or otherwise secured at a specific location. (680) (CMP-17)

N Fixed-in-Place. Mounting means of equipment using fasteners that require a tool for removal. (625) (CMP-12)

Δ Flameproof “d”. Type of protection where the enclosure will withstand an internal explosion of a flammable mixture that has penetrated into the interior, without suffering damage and without causing ignition, through any joints or structural openings in the enclosure of an external explosive gas atmosphere consisting of one or more of the gases or vapors for which it is designed. (CMP-14)

Informational Note: See ANSI/UL 60079-1, *Explosive Atmospheres — Part 1: Equipment Protection by Flameproof Enclosures “d”*, for additional information.

N Flammable Anesthetics. Gases or vapors, such as fluroxene, cyclopropane, divinyl ether, ethyl chloride, ethyl ether, and ethylene, that could form flammable or explosive mixtures with air, oxygen, or reducing gases such as nitrous oxide. (517) (CMP-15)

N Flexible Bus Systems. An assembly of flexible insulated bus, with a system of associated fittings used to secure, support, and terminate the bus. (CMP-8)

Informational Note: Flexible bus systems are engineered systems for a specific site location and are ordinarily assembled at the point of installation from the components furnished or specified by the manufacturer.

N Flexible Insulated Bus. A flexible rectangular conductor with an overall insulation. (CMP-8)

N Flywheel ESS (FESS). A mechanical ESS composed of a spinning mass referred to as a rotor and an energy conversion mechanism such as a motor-generator that converts the mechanical energy to electrical energy. (706) (CMP-13)

Informational Note: There are primarily two types of rotor constructions, solid metal mass design and composite fiber design.

N Footlight. A border light installed on or in the stage. (520) (CMP-15)

N Forming Shell. A structure designed to support a wet-niche luminaire assembly and intended for mounting in a pool or fountain structure. (680) (CMP-17)

N Fountain. An ornamental structure or recreational water feature from which one or more jets or streams of water are discharged into the air, including splash pads, ornamental pools, display pools, and reflection pools. The definition does not include drinking water fountains or water coolers. (680) (CMP-17)

N Frame. Chassis rail and any welded addition thereto of metal thickness of 1.35 mm (0.053 in.) or greater. (551) (CMP-7)

Free Air (as applied to conductors). Open or ventilated environment that allows for heat dissipation and air flow around an installed conductor. (CMP-6)

Fuel Cell. An electrochemical system that consumes fuel to produce an electric current. In such cells, the main chemical reaction used for producing electric power is not combustion. However, there may be sources of combustion used within the overall cell system, such as reformers/fuel processors. (CMP-4)

Fuel Cell System. The complete aggregate of equipment used to convert chemical fuel into usable electricity and typically consisting of a reformer, stack, power inverter, and auxiliary equipment. (CMP-4)

Fuse. An overcurrent protective device with a circuit-opening fusible part that is heated and severed by the passage of overcurrent through it. (CMP-10)

Informational Note: 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.

Fuse, Electronically Actuated. (Electronically Actuated Fuse) An overcurrent protective device that generally consists of a control module that provides current-sensing, electronically derived time-current characteristics, energy to initiate tripping, and an interrupting module that interrupts current when an overcurrent occurs. Such fuses may or may not operate in a current-limiting fashion, depending on the type of control selected. (CMP-10)

Δ Fuse, Expulsion. (Expulsion Fuse) A vented fuse unit in which the expulsion effect of gases produced by the arc and lining of the fuseholder, either alone or aided by a spring, extinguishes the arc. (CMP-10)

Fuse, Nonvented Power. (Nonvented Power Fuse) A fuse without intentional provision for the escape of arc gases, liquids, or solid particles to the atmosphere during circuit interruption. (CMP-10)

Fuse, Power. (Power Fuse) A vented, nonvented, or controlled vented fuse unit in which the arc is extinguished by being drawn through solid material, granular material, or liquid, either alone or aided by a spring. (CMP-10)

Fuse, Vented Power. (Vented Power Fuse) A fuse with provision for the escape of arc gases, liquids, or solid particles to the surrounding atmosphere during circuit interruption. (CMP-10)

Δ Garage. A building or portion of a building in which one or more self-propelled vehicles can be kept for use, sale, storage, rental, repair, exhibition, or demonstration purposes. (CMP-1)

Informational Note: See 511.1 for commercial garages, repair and storage.

Garage, Major Repair. (Major Repair Garage) A building or portions of a building where major repairs, such as engine overhauls, painting, body and fender work, welding or grinding, and repairs that require draining or emptying of the motor vehicle fuel tank are performed on motor vehicles, including associated floor space used for offices, parking, or showrooms. [30A:3.3.12.1] (CMP-14)

Garage, Minor Repair. (Minor Repair Garage) A building or portions of a building used for lubrication, inspection, and minor automotive maintenance work, such as engine tune-ups, replacement of parts, fluid changes (e.g., oil, antifreeze, transmission fluid, brake fluid, air-conditioning refrigerants), brake system repairs, tire rotation, and similar routine maintenance work, including the associated floor space used for offices, parking, or showrooms. [30A:3.3.12.2] (CMP-14)

N General-Purpose Cables, Cable Routing Assemblies, and Raceways. Cables, cable routing assemblies, and raceways are suitable for general-purpose applications and are resistant to the spread of fire. (722) (CMP-3)

Generating Capacity, Inverter. (Inverter Generating Capacity) The sum of parallel-connected inverter maximum continuous output power at 40°C in watts, kilowatts, volt-amperes, or kilovolt-amperes. (CMP-4)

N Generating Station. A plant wherein electric energy is produced by conversion from some other form of energy (e.g., chemical, nuclear, solar, wind, mechanical, or hydraulic) by means of suitable apparatus. (CMP-4)

N Generator (Generator Set). A machine that converts mechanical energy into electrical energy by means of a prime mover and alternator and/or inverter. (CMP-13)

N Generator, On-Site Standby. (On-Site Standby Generator) A facility producing electric power on site as the alternate supply of electric power. It differs from an on-site power production facility in that it is not constantly producing power. (695) (CMP-13)

N Grid Bus Rail. A combination of the busbar, the busbar support, and the structural suspended ceiling grid system. (393) (CMP-18)

Ground. The earth. (CMP-5)

Ground Fault. An unintentional, electrically conductive connection between an ungrounded conductor of an electrical circuit and the normally non-current-carrying conductors, metal enclosures, metal raceways, metal equipment, or earth. (CMP-5)

Δ Ground-Fault Circuit Interrupter (GFCI). A device intended for the protection of personnel that functions to de-energize a circuit or portion thereof within an established period of time when a ground-fault current exceeds the values established for a Class A device. (CMP-2)

Informational Note: See UL 943, *Standard for Ground-Fault Circuit Interrupters*, for further information. Class A ground-fault circuit interrupters trip when the ground-fault current is 6 mA or higher and do not trip when the ground-fault current is less than 4 mA.

N Ground-Fault Circuit Interrupter, Special Purpose (SPGFCI). (Special Purpose Ground-Fault Circuit Interrupter) A device intended for the detection of ground-fault currents, used in circuits with voltage to ground greater than 150 volts, that functions to de-energize a circuit or portion of a circuit within an established period of time when a ground-fault current exceeds the values established for Class C, D, or E devices. (CMP-2)

Informational Note: See UL 943C, *Outline of Investigation for Special Purpose Ground-Fault Circuit Interrupters*, for information on Classes C, D, or E special purpose ground-fault circuit interrupters.

Ground-Fault Current Path. An electrically conductive path from the point of a ground fault on a wiring system through normally non-current-carrying conductors, grounded conductors, equipment, or the earth to the electrical supply source. (CMP-5)

Informational Note: Examples of ground-fault current paths are any combination of equipment grounding conductors, metallic raceways, metallic cable sheaths, electrical equipment, and any other electrically conductive material such as metal, water, and gas piping; steel framing members; stucco mesh; metal ducting; reinforcing steel; shields of communications cables; grounded conductors; and the earth itself.

Ground-Fault Current Path, Effective. (Effective Ground-Fault Current Path) An intentionally constructed, low-impedance electrically conductive path designed and intended to carry current during ground-fault events from the point of a ground fault on a wiring system to the electrical supply source and that facilitates the operation of the overcurrent protective device or ground-fault detectors. (CMP-5)

N Ground-Fault Detector-Interrupter, dc (GFDI). A device that provides protection for PV system dc circuits by detecting a ground fault and could interrupt the fault path in the dc circuit. (690) (CMP-4)

Informational Note: See UL 1741, *Standard for Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy Resources*, and UL 62109, *Standard for Power Converters for use in Photovoltaic Power Systems*, for further information on GFDI equipment.

Ground-Fault Protection of Equipment (GFPE). A system intended to provide protection of equipment from damaging line-to-ground fault currents by operating to cause a disconnecting means to open all ungrounded conductors of the faulted circuit. This protection is provided at current levels less than those required to protect conductors from damage

through the operation of a supply circuit overcurrent device. (CMP-5)

Grounded (Grounding). Connected (connecting) to ground or to a conductive body that extends the ground connection. (CMP-5)

N Grounded, Functionally. (Functionally Grounded) A system that has an electrical ground reference for operational purposes that is not solidly grounded. (CMP-4)

Informational Note: A functionally grounded system is often connected to ground through an electronic means internal to an inverter or charge controller that provides ground-fault protection. Examples of operational purposes for functionally grounded systems include ground-fault detection and performance-related issues for some power sources.

Grounded, Solidly. (Solidly Grounded) Connected to ground without inserting any resistor or impedance device. (CMP-5)

Grounded Conductor. A system or circuit conductor that is intentionally grounded. (CMP-5)

Informational Note: Although an equipment grounding conductor is grounded, it is not considered a grounded conductor.

N Grounded System, Impedance. (Impedance Grounded System) An electrical system that is grounded by intentionally connecting the system neutral point to ground through an impedance device. (CMP-5)

Grounding Conductor, Equipment (EGC). (Equipment Grounding Conductor) A conductive path(s) that is part of an effective ground-fault current path and connects normally non-current-carrying metal parts of equipment together and to the system grounded conductor or to the grounding electrode conductor, or both. (CMP-5)

Informational Note No. 1: It is recognized that the equipment grounding conductor also performs bonding.

Informational Note No. 2: See 250.118 for a list of acceptable equipment grounding conductors.

N Grounding Conductor, Impedance. (Impedance Grounding Conductor) A conductor that connects the system neutral point to the impedance device in an impedance grounded system. (CMP-5)

Grounding Electrode. A conducting object through which a direct connection to earth is established. (CMP-5)

Grounding Electrode Conductor (GEC). A conductor used to connect the system grounded conductor or the equipment to a grounding electrode or to a point on the grounding electrode system. (CMP-5)

N Grouped. Cables or conductors positioned adjacent to one another but not in continuous contact with each other. (520) (CMP-15)

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. (CMP-1)

Guest Room. An accommodation combining living, sleeping, sanitary, and storage facilities within a compartment. (CMP-2)

Guest Suite. An accommodation with two or more contiguous rooms comprising a compartment, with or without doors between such rooms, that provides living, sleeping, sanitary, and storage facilities. (CMP-2)

N Gutter, Metal Auxiliary. (Metal Auxiliary Gutter) A sheet metal enclosure used to supplement wiring spaces at meter centers, distribution centers, switchgear, switchboards, and similar points of wiring systems. The enclosure has hinged or removable covers for housing and protecting electrical wires, cable, and busbars. The enclosure is designed for conductors to be laid or set in place after the enclosures have been installed as a complete system. (CMP-8)

N Gutter, Nonmetallic Auxiliary. (Nonmetallic Auxiliary Gutter) A flame-retardant, nonmetallic enclosure used to supplement wiring spaces at meter centers, distribution centers, switchgear, switchboards, and similar points of wiring systems. The enclosure has hinged or removable covers for housing and protecting electrical wires, cable, and busbars. The enclosure is designed for conductors to be laid or set in place after the enclosures have been installed as a complete system. (CMP-8)

Habitable Room. A room in a building for living, sleeping, eating, or cooking, but excluding bathrooms, toilet rooms, closets, hallways, storage or utility spaces, and similar areas. (CMP-2)

Handhole Enclosure. An enclosure for use in underground systems, provided with an open or closed bottom, and sized to allow personnel to reach into, but not enter, for the purpose of installing, operating, or maintaining equipment or wiring or both. (CMP-9)

N Hazard Current. For a given set of connections in an isolated power system, the total current that would flow through a low impedance if it were connected between either isolated conductor and ground. [99:3.3.72] (517) (CMP-15)

N Hazard Current, Fault. (Fault Hazard Current) The hazard current of a given isolated power system with all devices connected except the line isolation monitor. [99:3.3.72.1] (517) (CMP-15)

N Monitor Hazard Current. The hazard current of the line isolation monitor alone. [99:3.3.72.2] (517) (CMP-15)

N Total Hazard Current. The hazard current of a given isolated system with all devices, including the line isolation monitor, connected. [99:3.3.72.3] (517) (CMP-15)

N Header. Transverse metal raceways for electrical conductors, providing access to predetermined cells of a precast cellular concrete floor, thereby permitting the installation of electrical conductors from a distribution center to the floor cells. (CMP-8)

N Health Care Facilities. Buildings, portions of buildings, or mobile enclosures in which human medical, dental, psychiatric, nursing, obstetrical, or surgical care is provided. [99:3.3.73] (CMP-15)

Informational Note: Examples of health care facilities include, but are not limited to, hospitals, nursing homes, limited care facilities, clinics, medical and dental offices, and ambulatory care centers, whether permanent or movable.

N Health Care Facility's Governing Body. The person or persons who have the overall legal responsibility for the operation of a health care facility. [99:3.3.74] (517) (CMP-15)

N Heating Equipment. Any equipment that is used for heating purposes and whose heat is generated by induction or dielectric methods. (665) (CMP-12)

N Heating Panel. A complete assembly provided with a junction box or a length of flexible conduit for connection to a branch circuit. (CMP-17)

N Heating Panel Set. A rigid or nonrigid assembly provided with nonheating leads or a terminal junction assembly identified as being suitable for connection to a wiring system. (CMP-17)

N Heating System. A complete system consisting of components such as heating elements, fastening devices, nonheating circuit wiring, leads, temperature controllers, safety signs, junction boxes, raceways, and fittings. (426) (CMP-17)

N Heating System, Impedance. (Impedance Heating System) A system in which heat is generated in an object, such as a pipe, rod, or combination of such objects serving as a heating element, by causing current to flow through such objects by direct connection to an ac voltage source from an isolating transformer. In some installations the object is embedded in the surface to be heated or constitutes the exposed component to be heated. (CMP-17)

N Heating System, Induction. (Induction Heating System) A system in which heat is generated in a pipeline or vessel wall by inducing current in the pipeline or vessel wall from an external isolated ac field source. (CMP-17)

N Heating System, Skin Effect. (Skin-Effect Heating System) A system in which heat is generated on the inner surface of a ferromagnetic envelope embedded in or fastened to the surface to be heated.

Informational Note: Typically, an electrically insulated conductor is routed through and connected to the envelope at the other end. The envelope and the electrically insulated conductor are connected to an ac voltage source from an isolating transformer. (CMP-17)

Hermetic Refrigerant Motor-Compressor. A combination consisting of a compressor and motor, both of which are enclosed in the same housing, with no external shaft or shaft seals, with the motor operating in the refrigerant. (CMP-11)

Hoistway. Any shaftway, hatchway, well hole, or other vertical opening or space in which an elevator or dumbwaiter is designed to operate. (CMP-12)

N Hospital. A building or portion thereof used on a 24-hour basis for the medical, psychiatric, obstetrical, or surgical care of four or more inpatients. [101:3.3.152] (CMP-15)

N Host Sign. A sign or outline lighting system already installed in the field that is designated for field conversion of the illumination system with a retrofit kit. (600) (CMP-18)

N Hydromassage Bathtub. A permanently installed bathtub equipped with a recirculating piping system, pump, and associated equipment. It is designed so it can accept, circulate, and discharge water upon each use. (680) (CMP-17)

Identified (as applied to equipment). Recognizable as suitable for the specific purpose, function, use, environment, application, and so forth, where described in a particular *Code* requirement. (CMP-1)

Informational Note: Some examples of ways to determine suitability of equipment for a specific purpose, environment, or

application include investigations by a qualified testing laboratory (listing and labeling), an inspection agency, or other organizations concerned with product evaluation.

In Sight From (Within Sight From) (Within Sight). Equipment that is visible and not more than 15 m (50 ft) distant from other equipment is *in sight from* that other equipment. (CMP-1)

Informational Note: See 110.29 for additional information.

Δ Increased Safety “e”. Type of protection applied to electrical equipment that does not produce arcs or sparks in normal service and under specified abnormal conditions, in which additional measures are applied to give increased security against the possibility of excessive temperatures and of the occurrence of arcs and sparks. (CMP-14)

Informational Note: See ANSI/UL 60079-7, *Explosive Atmospheres — Part 7: Equipment Protection by Increased Safety “e”*, for additional information.

N Induction Heating (Induction Melting) (Induction Welding). The heating, melting, or welding of a nominally conductive material due to its own I²R losses when the material is placed in a varying electromagnetic field. (665) (CMP-12)

Δ Industrial Control Panel. An assembly of two or more components consisting of one of the following: (1) power circuit components only, such as motor controllers, overload relays, fused disconnect switches, and circuit breakers; (2) control circuit components only, such as push buttons, pilot lights, selector switches, timers, switches, and control relays; (3) a combination of power and control circuit components. These components, with associated wiring and terminals, are mounted on, or contained within, an enclosure or mounted on a subpanel. (CMP-11)

Informational Note: The industrial control panel does not include the controlled equipment.

N Industrial Installation, Supervised. (Supervised Industrial Installation) The industrial portions of a facility where all of the following conditions are met:

- (1) Conditions of maintenance and engineering supervision ensure that only qualified persons monitor and service the system.
- (2) The premises wiring system has 2500 kVA or greater of load used in industrial process(es), manufacturing activities, or both, as calculated in accordance with Article 220.
- (3) The premises has at least one service or feeder that is more than 150 volts to ground and more than 300 volts phase-to-phase.

This definition excludes installations in buildings used by the industrial facility for offices, warehouses, garages, machine shops, and recreational facilities that are not an integral part of the industrial plant, substation, or control center. (240) (CMP-10)

Δ Information Technology Equipment (ITE). Equipment and systems rated 1000 volts or less, normally found in offices or other business establishments and similar environments classified as ordinary locations, that are used for creation and manipulation of data, voice, video, and similar signals that are not communications equipment and do not process communications circuits. (CMP-12)

Informational Note: See UL 60950-1, *Information Technology Equipment — Safety — Part 1: General Requirements*, or UL 62368-1, *Audio/Video Information and Communication Technology Equipment*

Part 1: Safety Requirements, for information on listing requirements for both information technology equipment and communications equipment.

Information Technology Equipment Room. A room within the information technology equipment area that contains the information technology equipment. [75:3.3.15] (CMP-12)

Innerduct. A nonmetallic raceway placed within a larger raceway. (CMP-16)

N Insulated Bus Pipe (IBP). A cylindrical solid or hollow conductor with a solid insulation system, having conductive grading layers and a grounding layer imbedded in the insulation, and provided with an overall covering of insulating or metallic material. IBP is also referred to as tubular covered conductor (TCC). (CMP-8)

N Insulated Bus Pipe System. An assembly that includes bus pipe, connectors, fittings, mounting structures, and other fittings and accessories. (CMP-8)

N Insulating End. An insulator designed to electrically insulate the end of a flat conductor cable (Type FCC). (324) (CMP-6)

Interactive Mode. The operating mode for power production equipment or microgrids that operate in parallel with and are capable of delivering energy to an electric power production and distribution network or other primary source. (CMP-4)

Informational Note: Interactive mode is an operational mode of both interactive systems and of equipment such as interactive inverters.

Interrupting Rating. The highest current at rated voltage that a device is identified to interrupt under standard test conditions. (CMP-10)

Informational Note: Equipment intended to interrupt current at other than fault levels may have its interrupting rating implied in other ratings, such as horsepower or locked rotor current.

Intersystem Bonding Termination (IBT). A device that provides a means for connecting intersystem bonding conductors for communications systems to the grounding electrode system. (CMP-16)

Δ Intrinsic Safety “i”. Type of protection where any spark or thermal effect is incapable of causing ignition of a mixture of flammable or combustible material in air under prescribed test conditions. (CMP-14)

Informational Note: See ANSI/UL 913, *Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division I, Hazardous (Classified) Locations*; and ANSI/UL 60079-11, *Explosive Atmospheres — Part 11: Equipment Protection by Intrinsic Safety “i”*, for additional information.

Intrinsically Safe Apparatus. Apparatus in which all the circuits are intrinsically safe. (CMP-14)

Informational Note No. 1: See ANSI/UL 913, *Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations*, and ANSI/UL 60079-11, *Explosive Atmospheres — Part 11: Equipment Protection by Intrinsic Safety “i”*, for additional information.

Informational Note No. 2: See ANSI/ISA RP 12.06.01, *Recommended Practice for Wiring Methods for Hazardous (Classified) Locations Instrumentation — Part 1: Intrinsic Safety*, for installation information.

Δ Intrinsically Safe Circuit. A circuit in which any spark or thermal effect is incapable of causing ignition of a mixture of flammable or combustible material in air under prescribed test conditions. (CMP-14)

Informational Note: See ANSI/UL 913, *Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations*, and ANSI/UL 60079-11, *Explosive Atmospheres — Part 11: Equipment Protection by Intrinsic Safety “i”*, for test conditions.

Intrinsically Safe Circuits, Different. (Different Intrinsically Safe Circuits) Intrinsically safe circuits in which the possible interconnections have not been evaluated and identified as intrinsically safe. (CMP-14)

Informational Note: See ANSI/UL 913, *Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations*, and ANSI/UL 60079-11, *Explosive Atmospheres — Part 11: Equipment Protection by Intrinsic Safety “i”*, for additional information.

Intrinsically Safe System. An assembly of interconnected intrinsically safe apparatus, associated apparatus, and interconnecting cables, in which those parts of the system that might be used in hazardous (classified) locations are intrinsically safe circuits. (CMP-14)

Informational Note No. 1: An intrinsically safe system might include more than one intrinsically safe circuit.

Informational Note No. 2: See ANSI/UL 913, *Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations*; ANSI/UL 60079-11, *Explosive Atmospheres — Part 11: Equipment Protection by Intrinsic Safety “i”*; and ANSI/UL 60079-25, *Explosive Atmospheres — Part 25: Intrinsically Safe Electrical Systems*, for additional information.

Informational Note No. 3: See ANSI/ISA RP 12.06.01, *Recommended Practice for Wiring Methods for Hazardous (Classified) Locations Instrumentation — Part 1: Intrinsic Safety*, for installation information.

N Invasive Procedure. Any procedure that penetrates the protective surfaces of a patient’s body (i.e., skin, mucous membrane, cornea) and that is performed with an aseptic field (procedural site). [Not included in this category are placement of peripheral intravenous needles or catheters used to administer fluids and/or medications, gastrointestinal endoscopies (i.e., sigmoidoscopies), insertion of urethral catheters, and other similar procedures.] [99:3.3.91] (517) (CMP-15)

Inverter. Equipment that changes dc to ac. (CMP-4)

Inverter, Interactive. (Interactive Inverter) Inverter equipment having the capability to operate only in interactive mode. (CMP-13)

Inverter, Multimode. (Multimode Inverter) Inverter equipment capable of operating in both interactive and island modes. (CMP-4)

N Inverter, Stand-alone. (Stand-alone Inverter) Inverter equipment having the capabilities to operate only in island mode. (CMP-4)

Inverter Input Circuit. Conductors connected to the dc input of an inverter. (CMP-13)

Inverter Output Circuit. Conductors connected to the ac output of an inverter. (CMP-13)

N Inverter Utilization Output Circuit. Conductors between the multimode or stand-alone inverter and utilization equipment. (706) (CMP-13)

N Irrigation Machine. An electrically driven or controlled machine, with one or more motors, not hand-portable, and used primarily to transport and distribute water for agricultural purposes. (675) (CMP-7)

N Irrigation Machine, Center Pivot. (Center Pivot Irrigation Machine) A multimotored irrigation machine that revolves around a central pivot and employs alignment switches or similar devices to control individual motors. (675) (CMP-7)

Δ Island Mode. The operating mode for power production equipment or microgrids that allows energy to be supplied to loads that are disconnected from an electric power production and distribution network or other primary power source. (CMP-4)

Isolated (as applied to location). Not readily accessible to persons unless special means for access are used. (CMP-1)

N Isolated Power System. A system comprising an isolation transformer or its equivalent, a line isolation monitor, and its ungrounded circuit conductors. [99:3.3.93] (517) (CMP-15)

N Isolation Transformer. A transformer of the multiple-winding type, with the primary and secondary windings physically separated, that inductively couples its ungrounded secondary winding to the grounded feeder system that energizes its primary winding. [99:3.3.94] (517) (CMP-15)

Kitchen. An area with a sink and permanent provisions for food preparation and cooking. (CMP-2)

Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner. (CMP-1)

Informational Note: If a listed product is of such a size, shape, material, or surface texture that it is not possible to apply legibly the complete label to the product, the complete label may appear on the smallest unit container in which the product is packaged.

Laundry Area. An area containing or designed to contain a laundry tray, clothes washer, or clothes dryer. (CMP-2)

N Leakage-Current Detector-Interrupter (LCDI). A device provided in a power supply cord or cord set that senses leakage current flowing between or from the cord conductors and interrupts the circuit at a predetermined level of leakage current. (440) (CMP-11)

N LED Sign Illumination System. A complete lighting system for use in signs and outline lighting consisting of light-emitting diode (LED) light sources, power supplies, wire, and connectors to complete the installation. (600) (CMP-18)

N Legally Required Standby Systems. Those systems required and so classed as legally required standby by municipal, state, federal, or other codes or by any governmental agency having jurisdiction. These systems are intended to automatically supply

power to selected loads (other than those classed as emergency systems) in the event of failure of the normal source. (CMP-13)

N Life Safety Branch. A system of feeders and branch circuits supplying power for lighting, receptacles, and equipment essential for life safety that is automatically connected to alternate power sources by one or more transfer switches during interruption of the normal power source. [99:3.3.97] (517) (CMP-15)

N Lighting Assembly, Cord-and-Plug-Connected. (Cord-and-Plug-Connected Lighting Assembly) A lighting assembly consisting of a luminaire intended for installation in the wall of a spa, hot tub, or storable pool, and a cord-and-plug-connected transformer or power supply. (680) (CMP-17)

N Lighting Assembly, Through-Wall. (Through-Wall Lighting Assembly) A lighting assembly intended for installation above grade, on or through the wall of a pool, consisting of two interconnected groups of components separated by the pool wall. (680) (CMP-17)

Lighting Outlet. An outlet intended for the direct connection of a lampholder or luminaire. (CMP-18)

Δ Lighting Track. (Track Lighting) A manufactured assembly designed to support and energize luminaires that are capable of being readily repositioned on the track. Its length can be altered by the addition or subtraction of sections of track. (CMP-18)

N Limited Care Facility. A building or portion of a building used on a 24-hour basis for the housing of four or more persons who are incapable of self-preservation because of age; physical limitation due to accident or illness; or limitations such as intellectual disability/developmental disability, mental illness, or chemical dependency. [101:3.3.93.2] (CMP-15)

Δ Limited Finishing Workstation. A power-ventilated apparatus that is capable of confining the vapors, mists, residues, dusts, or deposits that are generated by a limited spray application process. Such apparatus is not a spray booth or spray room, as herein defined. [33:3.3.23.1] (CMP-14)

Informational Note: See NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials*, Section 14.3, for information on limited finishing workstations.

N Line Isolation Monitor. A test instrument designed to continually check the balanced and unbalanced impedance from each line of an isolated circuit to ground and equipped with a built-in test circuit to exercise the alarm without adding to the leakage current hazard. [99:3.3.99] (517) (CMP-15)

Δ Liquid Immersion “o”. Type of protection where electrical equipment is immersed in a protective liquid so that an explosive atmosphere that might be above the liquid or outside the enclosure cannot be ignited. (CMP-14)

Informational Note: See ANSI/UL 60079-6, *Explosive Atmospheres — Part 6: Equipment Protection by Liquid Immersion “o”*, for additional information.

Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or

service meets appropriate designated standards or has been tested and found suitable for a specified purpose. (CMP-1)

Informational Note: The means for identifying listed equipment may vary for each organization concerned with product evaluation, some of which do not recognize equipment as listed unless it is also labeled. Use of the system employed by the listing organization allows the authority having jurisdiction to identify a listed product.

Live Parts. Energized conductive components. (CMP-1)

N Load Management. The process within an energy management system that limits the total electrical load on an electrical supply system to a set value by adjusting or controlling the individual loads. (625) (CMP-12)

Informational Note: Load management is sometimes called *demand-side management* (DSM).

N Location, Anesthetizing. (Anesthetizing Location) Any space within a facility that has been designated for the administration of any flammable or nonflammable inhalation anesthetic agent during examination or treatment, including the use of such agents for relative analgesia. (517) (CMP-15)

N Location, Anesthetizing, Flammable. (Flammable Anesthetizing Location) Any area of the facility that has been designated to be used for the administration of any flammable inhalation anesthetic agents in the normal course of examination or treatment. (517) (CMP-15)

Location, Damp. (Damp Location) Locations protected from weather and not subject to saturation with water or other liquids but subject to moderate degrees of moisture. (CMP-1)

Informational Note: Examples of such locations include 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.

Location, Dry. (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. (CMP-1)

N Location, Remote. (Remote Location) A location, other than a motion picture or television studio, where a production is filmed or recorded. (530) (CMP-15)

Location, Wet. (Wet Location) A location that is one or more of the following:

- (1) Unprotected and exposed to weather
- (2) Subject to saturation with water and other liquids
- (3) Underground
- (4) In concrete slabs or masonry in direct contact with the earth

(CMP-1)

Informational Note: A vehicle washing area is an example of a wet location saturated with water or other liquids.

N Location, Wet Procedure. (Wet Procedure Location) The area in a patient care space where a procedure is performed that is normally subject to wet conditions while patients are present, including standing fluids on the floor or drenching of the work area, either of which condition is intimate to the patient or staff. [99:3.3.187] (517) (CMP-15)

Informational Note: Routine housekeeping procedures and incidental spillage of liquids do not define a wet procedure location. [99:A.3.3.187]

N Locations, Hazardous (Classified). [Hazardous (Classified) Locations] Locations where fire or explosion hazards might exist due to flammable gases, flammable liquid-produced vapors, combustible liquid-produced vapors, combustible dusts, combustible fiber/flyings, or ignitable fibers/flyings. (CMP-14)

Locations, Unclassified. (Unclassified Locations) Locations determined to be neither Class I, Division 1; Class I, Division 2; Zone 0; Zone 1; Zone 2; Class II, Division 1; Class II, Division 2; Class III, Division 1; Class III, Division 2; Zone 20; Zone 21; Zone 22; nor any combination thereof. (CMP-14)

N Long-Time Rating. A rating based on an operating interval of 5 minutes or longer. (660) (CMP-12)

N Long-Time Rating (Standby Power). A rating based on an operating interval of 5 minutes or longer. (517) (CMP-15)

N Loudspeaker (Speaker). Equipment that converts an ac electric signal into an acoustic signal. (640) (CMP-12)

N Low-Voltage Contact Limit. A voltage not exceeding the following values:

- (1) 15 volts (RMS) for sinusoidal ac
 - (2) 21.2 volts peak for nonsinusoidal ac
 - (3) 30 volts for continuous dc
 - (4) 12.4 volts peak for dc that is interrupted at a rate of 10 to 200 Hz
- (680) (CMP-17)

N Low-Voltage Suspended Ceiling Power Distribution System. A system that serves as a support for a finished ceiling surface and consists of a busbar and busbar support system to distribute power to utilization equipment supplied by a Class 2 power supply. (393) (CMP-18)

Luminaire. A complete lighting unit consisting of a light source such as a lamp or lamps, together with the parts designed to position the light source and connect it to the power supply. It may also include parts to protect the light source or the ballast or to distribute the light. A lampholder itself is not a luminaire. (CMP-18)

N Luminaire, Dry-Niche. (Dry-Niche Luminaire) A luminaire intended for installation in the floor or wall of a pool, spa, or fountain in a niche that is sealed against the entry of water. (680) (CMP-17)

N Luminaire, No-Niche. (No-Niche Luminaire) A luminaire intended for installation above or below the water without a niche. (680) (CMP-17)

N Luminaire, Wet-Niche. (Wet-Niche Luminaire) A luminaire intended for installation in a forming shell mounted in a pool or fountain structure where the luminaire will be completely surrounded by water. (680) (CMP-17)

N Machine Room. An enclosed machinery space outside the hoistway, intended for full bodily entry, that contains the electrical driving machine or the hydraulic machine. The room could also contain electrical and/or mechanical equipment used directly in connection with the elevator or dumbwaiter. (620) (CMP-12)

N Machine Room and Control Room, Remote. (Remote Machine Room and Control Room) A machine room or control room that is not attached to the outside perimeter or surface of the walls, ceiling, or floor of the hoistway. (620) (CMP-12)

N Machinery, Industrial (Industrial Machine). (Industrial Machinery) A power-driven machine (or a group of machines working together in a coordinated manner), not portable by hand while working, that is used to process material by cutting; forming; pressure; electrical, thermal, or optical techniques; lamination; or a combination of these processes. It can include associated equipment used to transfer material or tooling, including fixtures, to assemble/disassemble, to inspect or test, or to package. The associated electrical equipment, including the logic controller(s) and associated software or logic together with the machine actuators and sensors, are considered as part of the industrial machine. (CMP-12)

N Machinery Space. A space inside or outside the hoistway, intended to be accessed with or without full bodily entry, that contains the elevator, dumbwaiter, platform lift, or stairway chairlift equipment and could also contain equipment used directly in connection with the elevator, dumbwaiter, platform lift, or stairway chairlift. (620) (CMP-12)

N Machinery Space and Control Space, Remote. (Remote Machinery Space and Control Space) A machinery space or control space that is not within the hoistway, machine room, or control room and that is not attached to the outside perimeter or surface of the walls, ceiling, or floor of the hoistway. (620) (CMP-12)

N Manufactured Home. A structure, transportable in one or more sections, which in the traveling mode is 2.4 m (8 ft) or more in width or 12.2 m (40 ft) or more in length, or when erected on site is 29.77 m² (320 ft²) or more is built on a permanent chassis and is designed to be used as a dwelling with or without a permanent foundation, whether or not connected to the utilities, and includes plumbing, heating, air conditioning, and electrical systems contained therein. The term includes any structure that meets all the requirements of this paragraph except the size requirements and with respect to which the manufacturer voluntarily files a certification required by the regulatory agency. Calculations used to determine the number of square meters (square feet) in a structure are based on the structure's exterior dimensions and include all expandable rooms, cabinets, and other projections containing interior space, but do not include bay windows. [501:1.2.12] (CMP-7)

Informational Note No. 1: Unless otherwise indicated, the term *mobile home* includes manufactured home and excludes park trailers.

Informational Note No. 2: See the applicable building code for definition of the term *permanent foundation*.

Informational Note No. 3: See 24 CFR Part 3280, *Manufactured Home Construction and Safety Standards*, of the Federal Department of Housing and Urban Development, for additional information on the definition.

N Manufactured Wiring System. A system containing component parts that are assembled in the process of manufacture and cannot be inspected at the building site without damage or destruction to the assembly and used for the connection of luminaires, utilization equipment, continuous plug-in type busways, and other devices. (604) (CMP-7)

N Marina. A facility, generally on the waterfront, that stores and services boats in berths, on moorings, and in dry storage or dry stack storage. [303:3.3.13] (555) (CMP-7)

N Maximum Output Power. The maximum power delivered by an amplifier into its rated load as determined under specified test conditions. (640) (CMP-12)

Informational Note: The maximum output power can exceed the manufacturer's rated output power for the same amplifier.

N Maximum Output Power. The maximum 1 minute average power output a wind turbine produces in normal steady-state operation (instantaneous power output can be higher). (694) (CMP-4)

N Maximum Voltage. The greatest difference in potential produced between any two conductors of a wind turbine circuit. (694) (CMP-4)

N Maximum Water Level. The highest level that water can reach before it spills out. (680) (CMP-17)

N Medical Office. A building or part thereof in which the following occur:

- (1) Examinations and minor treatments/procedures performed under the continuous supervision of a medical professional;
- (2) The use of limited to minimal sedation and treatment or procedures that do not render the patient incapable of self-preservation under emergency conditions; and
- (3) No overnight stays for patients or 24-hour operations. [99:3.3.110] (CMP-15)

Δ Membrane Enclosure. A temporary enclosure used for the spraying of workpieces that cannot be moved into a spray booth where open spraying is not practical due to proximity to other operations, finish quality, or concerns such as the collection of overspray. (CMP-14)

Informational Note: See NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials*, Chapter 18, for information on the construction and use of membrane enclosures.

N Messenger-Supported Wiring. An exposed wiring support system using a messenger wire to support insulated conductors by any one of the following:

- (1) A messenger with rings and saddles for conductor support
- (2) A messenger with a field-installed lashing material for conductor support
- (3) Factory-assembled aerial cable
- (4) Multiplex cables utilizing a bare conductor, factory assembled and twisted with one or more insulated conductors, such as duplex, triplex, or quadruplex type of construction

(CMP-6)

Messenger Wire (Messenger). A wire that is run along with or integral with a cable or conductor to provide mechanical support for the cable or conductor. (CMP-6)

N Metal Shield Connections. Means of connection for flat conductor cables (Type FCC) designed to electrically and mechanically connect a metal shield to another metal shield, to a receptacle housing or self-contained device, or to a transition assembly. (324) (CMP-6)

N Microgrid. An electric power system capable of operating in island mode and capable of being interconnected to an electric power production and distribution network or other primary source while operating in interactive mode, which includes the ability to disconnect from and reconnect to a primary source and operate in island mode. (CMP-4)

Informational Note No. 1: See IEEE 1547, *IEEE Standard for Interconnection and Interoperability of Distributed Energy Resources with Associated Electric Power Systems Interface*; IEEE 2030.7, *IEEE Standard for the Specification of Microgrid Controllers*; IEEE 2030.8, *IEEE Standard for the Testing of Microgrid Controllers*; and UL1008B, *Outline for Source Interconnection*, for additional information about microgrids.

Informational Note No. 2: Examples of power sources in microgrids include such items as photovoltaic systems, generators, fuel cell systems, wind electric systems, energy storage systems, electric vehicles that are used as a source of supply, and electrical power conversion from other energy sources.

N Microgrid, Health Care (Health Care Microgrid System). (Health Care Microgrid) A group of interconnected loads and distributed energy resources within clearly defined boundaries that acts as a single controllable entity with respect to the utility. [99:3.3.75] (517) (CMP-15)

N Microgrid Control System (MCS). A structured control system that manages microgrid operations, functionalities for utility interoperability, islanded operations, and transitions. (CMP-4)

Informational Note: MCS differ from multiple standby generators or uninterruptible power supplies that are evaluated and rated to operate as a single source of backup power upon loss of the primary power source. MCS functions include coordination, transitions, and interoperability between multiple power sources.

N Microgrid Interconnect Device (MID). A device that enables a microgrid system to separate from and reconnect to an interconnected primary power source. (CMP-4)

N Mixer. Equipment used to combine and level match a multiplicity of electronic signals, such as from microphones, electronic instruments, and recorded audio. (640) (CMP-12)

N Mobile. X-ray equipment mounted on a permanent base with wheels and/or casters for moving while completely assembled. (660) (CMP-12)

N Mobile Home. A factory-assembled structure or structures transportable in one or more sections that are built on a permanent chassis and designed to be used as a dwelling without a permanent foundation where connected to the required utilities and that include the plumbing, heating, air-conditioning, and electrical systems contained therein. (CMP-7)

Informational Note: Unless otherwise indicated, the term *mobile home* includes manufactured home and excludes park trailers.

N Mobile Home Lot. A designated portion of a mobile home park designed for the accommodation of one mobile home and its accessory buildings or structures for the exclusive use of its occupants. (550) (CMP-7)

N Mobile Home Park. A contiguous parcel of land that is used for the accommodation of mobile homes that are intended to be occupied. (550) (CMP-7)

N Module, AC. (AC Module) A complete, environmentally protected unit consisting of solar cells, inverter, and other components, designed to produce ac power. (690) (CMP-4)

N Module System, AC. (AC Module System) An assembly of ac modules, wiring methods, materials, and subassemblies that are evaluated, identified, and defined as a system. (690) (CMP-4)

N Momentary Rating. A rating based on an operating interval that does not exceed 5 seconds. (660) (CMP-12)

N Momentary Rating (Maximum Power). A rating based on an operating interval that does not exceed 5 seconds. (517) (CMP-15)

N Monitor. An electrical or electronic means to observe, record, or detect the operation or condition of the electric power system or apparatus. (750) (CMP-13)

N Monopole Circuit. An electrical subset of a PV system that has two conductors in the output circuit, one positive (+) and one negative (-). (690) (CMP-4)

N Monorail. Overhead track and hoist system for moving material around the boatyard or moving and launching boats. [303:3.3.16] (555) (CMP-7)

N Mooring(s). Any place where a boat is wet stored or berthed. [303:3.3.17] (555) (CMP-7)

N Motion Picture Studio (Television Studio). A building, group of buildings, other structures, and outdoor areas designed, constructed, permanently altered, designated, or approved for the purpose of motion picture or television production. (530) (CMP-15)

Motor Control Center. An assembly of one or more enclosed sections having a common power bus and principally containing motor control units. (CMP-11)

Δ Motor Fuel Dispensing Facility. That portion of a property where motor fuels are stored and dispensed from fixed equipment into the fuel tanks of motor vehicles or marine craft or into approved containers, including all equipment used in connection therewith. [30A:3.3.11] (CMP-14)

Informational Note: See 511.1 with respect to electrical wiring and equipment for other areas used as lubricatoriums, service rooms, repair rooms, offices, salesrooms, compressor rooms, and similar locations.

N Multi-Circuit Cable Outlet Enclosure. An enclosure containing one or more multi-circuit plugs, receptacles, or both. (520) (CMP-15)

Δ Multioutlet Assembly. A surface, flush, or freestanding assemblage with a raceway and fittings or other enclosure provided with one or more receptacles, for the purpose of supplying power to utilization equipment. (CMP-18)

N Nacelle. An enclosure housing the alternator and other parts of a wind turbine. (694) (CMP-4)

N Neon Tubing. Electric-discharge luminous tubing, including cold cathode luminous tubing, that is manufactured into shapes to illuminate signs, form letters, parts of letters, skeleton tubing, outline lighting, other decorative elements, or art forms and filled with various inert gases. (600) (CMP-18)

N Network Interface Unit (NIU). A device that converts a broadband signal into component voice, audio, video, data, and

interactive services signals and provides isolation between the network power and the premises signal circuits. These devices often contain primary and secondary protectors. (CMP-16)

N Network Terminal. A device that converts network-provided signals (optical, electrical, or wireless) into component signals, including voice, audio, video, data, wireless, optical, and interactive services, and is considered a network device on the premises that is connected to a communications service provider and is powered at the premises. (CMP-16)

Neutral Conductor. The conductor connected to the neutral point of a system that is intended to carry current under normal conditions. (CMP-5)

Neutral Point. The common point on a wye-connection in a polyphase system or midpoint on a single-phase, 3-wire system, or midpoint of a single-phase portion of a 3-phase delta system, or a midpoint of a 3-wire, direct-current system. (CMP-5)

Informational Note: At the neutral point of the system, the vectorial sum of the nominal voltages from all other phases within the system that utilize the neutral, with respect to the neutral point, is zero potential.

Nonautomatic. Requiring human intervention to perform a function. (CMP-1)

Δ Nonincendive Circuit. A circuit, other than field wiring, in which any arc or thermal effect produced under intended operating conditions of the equipment, is not capable, under specified test conditions, of igniting the flammable gas-air, vapor-air, or dust-air mixture. (CMP-14)

Informational Note: See ANSI/UL 121201, *Nonincendive Electrical Equipment for Use in Class I and II, Division 2 and Class III, Divisions 1 and 2 Hazardous (Classified) Locations*, for additional information.

Δ Nonincendive Component. A component having contacts for making or breaking an incendive circuit and the contacting mechanism is constructed so that the component is incapable of igniting the specified flammable gas-air or vapor-air mixture. The housing of such a component is not intended to exclude the flammable atmosphere or contain an explosion. (CMP-14)

Informational Note: See ANSI/UL 121201, *Nonincendive Electrical Equipment for Use in Class I and II, Division 2 and Class III, Divisions 1 and 2 Hazardous (Classified) Locations*, for additional information.

Δ Nonincendive Equipment. Equipment having electrical/electronic circuitry that is incapable, under normal operating conditions, of causing ignition of a specified flammable gas-air, vapor-air, or dust-air mixture due to arcing or thermal means. (CMP-14)

Informational Note: See ANSI/UL 121201, *Nonincendive Electrical Equipment for Use in Class I and II, Division 2 and Class III, Divisions 1 and 2 Hazardous (Classified) Locations*, for additional information.

Nonincendive Field Wiring. Wiring that enters or leaves an equipment enclosure and, under normal operating conditions of the equipment, is not capable, due to arcing or thermal effects, of igniting the flammable gas-air, vapor-air, or dust-air mixture. Normal operation includes opening, shorting, or grounding the field wiring. (CMP-14)

Informational Note: See ANSI/UL 121201, *Nonincendive Electrical Equipment for Use in Class I and II, Division 2 and Class III, Divi-*

sions 1 and 2 Hazardous (Classified) Locations, for additional information.

Δ Nonincendive Field Wiring Apparatus. Apparatus intended to be connected to nonincendive field wiring. (CMP-14)

Informational Note: See ANSI/UL 121201, *Nonincendive Electrical Equipment for Use in Class I and II, Division 2 and Class III, Divisions 1 and 2 Hazardous (Classified) Locations*, for additional information.

Nonlinear Load. A load where the wave shape of the steady-state current does not follow the wave shape of the applied voltage. (CMP-1)

Informational Note: Electronic equipment, electronic/electric-discharge lighting, adjustable-speed drive systems, and similar equipment may be nonlinear loads.

N Nonmetallic Extension. An assembly of two insulated conductors within a nonmetallic jacket or an extruded thermoplastic covering. The classification includes surface extensions intended for mounting directly on the surface of walls or ceilings. (CMP-6)

N Nonsparking. Constructed to minimize the risk of arcs or sparks capable of creating an ignition hazard during conditions of normal operation. (CMP-14)

Informational Note: See ANSI/UL 121201, *Nonincendive Electrical Equipment for Use in Class I and II, Division 2 and Class III, Divisions 1 and 2 Hazardous (Classified) Locations*, for additional information.

N Normal/Emergency Power Source. A power source on the output side of a transfer switch or uninterruptible power supply that is automatically available upon loss of normal power. (700) (CMP-13).

N Normal High-Water Level (as applies to electrical datum plane distances). Natural or Artificially Made Shorelines: An elevation delineating the highest water level that has been maintained for a sufficient period of time to leave evidence upon the landscape, commonly the point where the natural vegetation changes from predominantly aquatic to predominantly terrestrial.

Rivers and Streams: The elevation of the top of the bank of the channel. Streams, rivers, and tributaries that are prone to flooding and effects of water runoff shall consider the “bank-full stage” where an established gauge height at a given location along a river or stream, above which a rise in water surface will cause the river or stream to overflow the lowest natural stream bank somewhere in the corresponding reach.

Flood Control Bodies of Water: The flood pool maximum water surface elevation of a reservoir, equal to the elevation of the spillway.

Nonflood Control Bodies of Water: The flowage easement boundary in which the highest water surface elevation defined by the area existing between governmental-owned property line(s) and a contour line with perpetual rights to flood the area in connection with the operation of the reservoir.

(CMP-7)

N Nurses’ Station. A space intended to provide a center of nursing activity for a group of nurses serving bed patients, where patient calls are received, nurses dispatched, nurses’ notes written, inpatient charts prepared, and medications prepared for distribution to patients. Where such activities are carried on in

more than one location within a nursing unit, all such separate spaces are considered a to be parts of the nurses’ station. (517) (CMP-15)

N Nursing Home. A building or portion of a building used on a 24-hour basis for the housing and nursing care of four or more persons who, because of mental or physical incapacity, might be unable to provide for their own needs and safety without the assistance of another person. [101:3.3.150.2] (CMP-15)

N Office Furnishing. Cubicle panels, partitions, study carrels, workstations, desks, shelving systems, and storage units that may be mechanically and electrically interconnected to form an office furnishing system. (CMP-18)

Oil Immersion. Electrical equipment immersed in a protective liquid so that an explosive atmosphere that might be above the liquid or outside the enclosure cannot be ignited. (CMP-14)

Informational Note: See ANSI/UL 121201, *Nonincendive Electrical Equipment for Use in Class I and II, Division 2 and Class III, Divisions 1 and 2 Hazardous (Classified) Locations*, for additional information.

N Open Wiring on Insulators. 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. (CMP-6)

N Operating Device. The car switch, pushbuttons, key or toggle switch(s), or other devices used to activate the operation controller. (620) (CMP-12)

N Operator. The individual responsible for starting, stopping, and controlling an amusement ride or supervising a concession. (525) (CMP-15)

Δ Optical Radiation. Electromagnetic radiation at wavelengths in vacuum between the region of transition to X-rays and the region of transition to radio waves that is approximately between 1 nm and 1000 μm. (CMP-14)

Informational Note: See ANSI/UL 60079-28, *Explosive Atmospheres — Part 28: Protection of Equipment and Transmission Systems Using Optical Radiation*, for information on types of protection that can be applied to minimize the risk of ignition in explosive atmospheres from optical radiation in the wavelength range from 380 nm to 10 μm.

Δ Optical Radiation, Inherently Safe “op is”. (Inherently Safe Optical Radiation “op is”) Type of protection to minimize the risk of ignition in explosive atmospheres from optical radiation where visible or infrared radiation is incapable of producing sufficient energy under normal or specified fault conditions to ignite a specific explosive atmosphere. (CMP-14)

Informational Note: See ANSI/UL 60079-28, *Explosive Atmospheres — Part 28: Protection of Equipment and Transmission Systems Using Optical Radiation*, for additional information.

Δ Optical Radiation, Protected “op pr”. (Protected Optical Radiation “op pr”) Type of protection to minimize the risk of ignition in explosive atmospheres from optical radiation where visible or infrared radiation is confined inside optical fiber or other transmission medium under normal constructions or constructions with additional mechanical protection based on the assumption that there is no escape of radiation from the confinement. (CMP-14)

Informational Note: See ANSI/UL 60079-28, *Explosive Atmospheres — Part 28: Protection of Equipment and Transmission Systems Using Optical Radiation*, for additional information.

Δ Optical System With Interlock “op sh”. Type of protection to minimize the risk of ignition in explosive atmospheres from optical radiation where visible or infrared radiation is confined inside optical fiber or other transmission medium with interlock cutoff provided to reliably reduce the unconfined beam strength to safe levels within a specified time in case the confinement fails and the radiation becomes unconfined. (CMP-14)

Informational Note: See ANSI/UL 60079-28, *Explosive Atmospheres — Part 28: Protection of Equipment and Transmission Systems Using Optical Radiation*, for additional information.

N Optional Standby Systems. Those systems intended to supply power to public or private facilities or property where life safety does not depend on the performance of the system. These systems are intended to supply on-site generated or stored power to selected loads either automatically or manually. (CMP-13)

N Organ, Electronic. (Electronic Organ) A musical instrument that imitates the sound of a pipe organ by producing sound electronically. (CMP-12)

Informational Note: Most new electronic organs produce sound digitally and are called digital organs.

N Organ, Pipe. (Pipe Organ) A musical instrument that produces sound by driving pressurized air (called *wind*) through pipes selected via a keyboard. (CMP-12)

N Organ, Pipe Sounding Apparatus. (Pipe Organ Sounding Apparatus) (Pipe Organ Chamber). The sound-producing part of a pipe organ, including, but not limited to, pipes, chimes, bells, the pressurized air- (wind-) producing equipment (blower), associated controls, and power equipment. (CMP-12)

Outlet. A point on the wiring system at which current is taken to supply utilization equipment. (CMP-1)

N Outlet Box Hood. A housing shield intended to fit over a faceplate for flush-mounted wiring devices, or an integral component of an outlet box or of a faceplate for flush-mounted wiring devices. The hood does not serve to complete the electrical enclosure; it reduces the risk of water coming in contact with electrical components within the hood, such as attachment plugs, current taps, surge protective devices, direct plug-in transformer units, or wiring devices. (CMP-18)

Outline Lighting. An arrangement of incandescent lamps, electric-discharge lighting, or other electrically powered light sources to outline or call attention to certain features such as the shape of a building or the decoration of a window. (CMP-18)

N Output Cable to the Electric Vehicle. An assembly consisting of a length of flexible EV cable and an electric vehicle connector (supplying power to the electric vehicle). (625) (CMP-12)

N Output Cable to the Primary Pad. A multiconductor, shielded cable assembly consisting of conductors to carry the high-frequency energy and any status signals between the charger power converter and the primary pad. (625) (CMP-12)

Overcurrent. Any current in excess of the rated current of equipment or the ampacity of a conductor. It may result from overload, short circuit, or ground fault. (CMP-10)

Informational Note: A current in excess of rating may be accommodated by certain equipment and conductors for a given set of conditions. Therefore, the rules for overcurrent protection are specific for particular situations.

Δ Overcurrent Protective Device, Branch-Circuit. (Branch-Circuit Overcurrent Protective Device) A device capable of providing protection for service, feeder, and branch circuits and equipment over the full range of overcurrents between its rated current and its interrupting rating. (CMP-10)

N Overcurrent Protective Device, Current-Limiting. (Current-Limiting Overcurrent Protective Device) A device that, when interrupting currents in its current-limiting range, reduces the current flowing in the faulted circuit to a magnitude substantially less than that obtainable in the same circuit if the device were replaced with a solid conductor having comparable impedance. (240) (CMP-10)

Overcurrent Protective Device, Supplementary. (Supplementary Overcurrent Protective Device) A device intended to provide limited overcurrent protection for specific applications and utilization equipment such as luminaires and appliances. This limited protection is in addition to the protection provided in the required branch circuit by the branch-circuit overcurrent protective device. (CMP-10)

N Overhead Gantry. A structure consisting of horizontal framework, supported by vertical columns spanning above electrified truck parking spaces, that supports equipment, appliances, raceway, and other necessary components for the purpose of supplying electrical, HVAC, internet, communications, and other services to the spaces. (626) (CMP-12)

Overload. Operation of equipment in excess of normal, full-load rating, or of a conductor in excess of its ampacity that, when it persists for a sufficient length of time, would cause damage or dangerous overheating. A fault, such as a short circuit or ground fault, is not an overload. (CMP-10)

N Packaged Therapeutic Tub or Hydrotherapeutic Tank Equipment Assembly. A factory-fabricated unit consisting of water-circulating, heating, and control equipment mounted on a common base, intended to operate a therapeutic tub or hydrotherapeutic tank. Equipment can include pumps, air blowers, heaters, lights, controls, sanitizer generators, and so forth. (680) (CMP-17)

Panelboard. A single panel or group of panel units designed for assembly in the form of a single panel, including buses and automatic overcurrent devices, and equipped with or without switches for the control of light, heat, or power circuits; designed to be placed in a cabinet, enclosure, or cutout box placed in or against a wall, partition, or other support; and accessible only from the front. (CMP-9)

N Panelboard, Enclosed. (Enclosed Panelboard) An assembly of buses and connections, overcurrent devices, and control apparatus with or without switches or other equipment, installed in a cabinet, cutout box, or enclosure suitable for a panelboard application. (CMP-9)

N Park Electrical Wiring Systems. All of the electrical wiring, luminaires, equipment, and appurtenances related to electrical installations within a mobile home park, including the mobile home service equipment. (550) (CMP-7)

N Park Trailer. A unit that is built on a single chassis mounted on wheels and has a gross trailer area not exceeding 37 m² (400 ft²) in the set-up mode. (552) (CMP-7)

N Part-Winding Motors. A part-winding start induction or synchronous motor is one that is arranged for starting by first energizing part of its primary (armature) winding and, subsequently, energizing the remainder of this winding in one or more steps. A standard part-winding start induction motor is arranged so that one-half of its primary winding can be energized initially, and, subsequently, the remaining half can be energized, both halves then carrying equal current. (CMP 11)

Informational Note: A hermetic refrigerant motor-compressor is not considered a standard part-winding start induction motor.

N Passenger Transportation Facilities. Any area open to the public associated with passenger transportation such as an airport, bus terminal, highway rest stop and service area, marina, seaport, ferry slip, subway station, train station, or port of entry. (CMP-18)

N Patient Bed Location. The location of a patient sleeping bed, or the bed or procedure table of a Category 1 space. [99:3.3.138] (CMP-15)

N Patient Care-Related Electrical Equipment. Electrical equipment appliance that is intended to be used for diagnostic, therapeutic, or monitoring purposes in a patient care vicinity. [99:3.3.139] (517) (CMP-15)

N Patient Care Space Category. Any space of a health care facility wherein patients are intended to be examined or treated. [99:3.3.140] (517) (CMP-15)

Informational Note No. 1: The health care facility's governing body designates patient care space in accordance with the type of patient care anticipated.

Informational Note No. 2: Business offices, corridors, lounges, day rooms, dining rooms, or similar areas typically are not classified as patient care spaces. [99:A.3.3.140]

N Category 1 Space (Category 1). Space in which failure of equipment or a system is likely to cause major injury or death of patients, staff, or visitors. [99:3.3.140.1] (CMP-15)

Informational Note: These spaces, formerly known as critical care rooms, are typically where patients are intended to be subjected to invasive procedures and connected to line-operated, patient care-related appliances. Examples include, but are not limited to, special care patient rooms used for critical care, intensive care, and special care treatment rooms such as angiography laboratories, cardiac catheterization laboratories, delivery rooms, operating rooms, post-anesthesia care units, trauma rooms, and other similar rooms. [99:A.3.3.140.1]

N Category 2 Space (Category 2). Space in which failure of equipment or a system is likely to cause minor injury to patients, staff, or visitors. [99:3.3.140.2] (CMP-15)

Informational Note: These spaces were formerly known as general care rooms. Examples include, but are not limited to, inpatient bedrooms, dialysis rooms, in vitro fertilization rooms, procedural rooms, and similar rooms. [99:A.3.3.140.2]

N Category 3 Space (Category 3). Space in which the failure of equipment or a system is not likely to cause injury to patients, staff, or visitors but can cause discomfort. [99:3.3.140.3] (517) (CMP-15)

Informational Note: These spaces, formerly known as basic care rooms, are typically where basic medical or dental care, treatment, or examinations are performed. Examples include, but are not limited to, examination or treatment rooms in clinics, medical and dental offices, nursing homes, and limited care facilities. [99:A.3.3.140.3]

N Category 4 Space (Category 4). Space in which failure of equipment or a system is not likely to have a physical impact on patient care. [99:3.3.140.4] (517) (CMP-15)

Informational Note: These spaces were formerly known as support rooms. Examples of support spaces include, but are not limited to, anesthesia work rooms, sterile supply, laboratories, morgues, waiting rooms, utility rooms, and lounges. [99:A.3.3.140.4]

N Patient Care Vicinity. A space, within a location intended for the examination and treatment of patients, extending 1.8 m (6 ft) beyond the normal location of the bed, chair, table, treadmill, or other device that supports the patient during examination and treatment and extending vertically to 2.3 m (7 ft 6 in.) above the floor. [99:3.3.141] (517) (CMP-15)

N Patient Equipment Grounding Point. A jack or terminal that serves as the collection point for redundant grounding of electric appliances serving a patient care vicinity or for grounding other items in order to eliminate electromagnetic interference problems. [99:3.3.142] (517) (CMP-15)

N Performance Area. The stage and audience seating area associated with a temporary stage structure, whether indoors or outdoors, constructed of scaffolding, truss, platforms, or similar devices, that is used for the presentation of theatrical or musical productions or for public presentations. (520) (CMP-15)

N Permanent Amusement Attraction. A ride device, entertainment device, or a combination of both that is installed such that portability or relocation is impracticable. (522) (CMP-15)

N 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 fountain cannot be readily disassembled for storage, whether or not served by electrical circuits of any nature. These units are primarily constructed for their aesthetic value and are not intended for swimming or wading. (680) (CMP-17)

N Personnel Protection System (as applied to EVSE). A system of personnel protection devices and constructional features that when used together provide protection against electric shock of personnel. (625) (CMP-12)

N Phase, Manufactured. (Manufactured Phase) The phase that originates at the phase converter and is not solidly connected to either of the single-phase input conductors. (CMP-13)

N Phase Converter. An electrical device that converts single-phase power to 3-phase electric power. (CMP-13)

Informational Note: Phase converters have characteristics that modify the starting torque and locked-rotor current of motors served, and consideration is required in selecting a phase converter for a specific load.

N Phase Converter, Rotary. (Rotary-Phase Converter) A device that consists of a rotary transformer and capacitor panel(s) that permits the operation of 3-phase loads from a single-phase supply. (455) (CMP-13)

- Phase Converter, Static. (Static-Phase Converter)** A device without rotating parts, sized for a given 3-phase load to permit operation from a single-phase supply. (455) (CMP-13)
- Photovoltaic Cell (PV). (Solar Cell).** The basic photovoltaic device that generates dc electricity when exposed to light. (CMP-4)
- Pier.** A structure extending over the water and supported on a fixed foundation (fixed pier), or on flotation (floating pier), that provides access to the water. [303:3.3.18] (CMP-7)
- Pier, Fixed. (Fixed Pier)** Pier constructed on a permanent, fixed foundation, such as on piles, that permanently establishes the elevation of the structure deck with respect to land. [303:3.3.18.2] (CMP-7)
- Pier, Floating. (Floating Pier)** Pier designed with inherent flotation capability that allows the structure to float on the water surface and rise and fall with water level changes. [303:3.3.18.3] (CMP-7)
- Pipeline.** A length of pipe including pumps, valves, flanges, control devices, strainers, and/or similar equipment for conveying fluids. (CMP-17)
- Plenum.** A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system. (CMP-3)
- Plenum Cable, Cable Routing Assemblies, and Raceways.** Cables, cable routing assemblies, and raceways that have adequate fire-resistant and low smoke-producing characteristics and are suitable for use in ducts, plenums, and other spaces used for environmental air. (722) (CMP-3)
- Point of Entrance.** The point within a building at which the wire or cable emerges from an external wall, from the roof, or from a concrete floor slab. (CMP-16)
- Pool.** Manufactured or field-constructed equipment designed to contain water on a permanent or semipermanent basis and used for swimming, wading, immersion, or therapeutic purposes. (680) (CMP-17)
- Pool, Immersion. (Immersion Pool)** A pool for ceremonial or ritual immersion of users, which is designed and intended to have its contents drained or discharged. (680) (CMP-17)
- Pool, Permanently Installed Swimming, Wading, Immersion, and Therapeutic. (Permanently Installed Swimming, Wading, Immersion, and Therapeutic Pools)** Those that are constructed or installed in the ground or partially in the ground, and all pools installed inside of a building, whether or not served by electrical circuits of any nature. (680) (CMP-17)
- Pool, Storable; used for Swimming, Wading, or Immersion (Storable Immersion Pool). (Storable Pool)** Pools installed entirely on or above the ground that are intended to be stored when not in use and are designed for ease of relocation, regardless of water depth. (680) (CMP-17)
- Pool Cover, Electrically Operated. (Electrically Operated Pool Cover)** Motor-driven equipment designed to cover and uncover the water surface of a pool by means of a flexible sheet or rigid frame. (680) (CMP-17)
- Pool Lift, Electrically Powered. (Electrically Powered Pool Lift)** An electrically powered lift that provides accessibility for people with disabilities to and from a pool or spa. (680) (CMP-17)
- Portable.** A device intended for indoor or outdoor use that is designed to be hand-carried from location to location, or easily transported without the use of other devices or equipment. (625) (CMP-12)
- Portable.** X-ray equipment designed to be hand-carried. (660) (CMP-12)
- Portable (as applied to equipment).** Equipment that is actually moved or can easily be moved from one place to another in normal use. (680) (CMP-17)
- Portable Power Distribution Unit.** A power distribution box containing receptacles and overcurrent devices. (520) (CMP-15)
- Informational Note: See ANSI/UL 1640, *Portable Power-Distribution Equipment*, for information on portable power distribution units.
- Portable Structures.** Units designed to be moved including, but not limited to, amusement rides, attractions, concessions, tents, trailers, trucks, and similar units. (525) (CMP-15)
- Portable Substation.** A portable assembly, usually mounted on a trailer, containing primary and secondary switchgear and a transformer. (530) (CMP-15)
- Powder Filling “q”.** Type of protection where electrical parts capable of igniting an explosive atmosphere are fixed in position and completely surrounded by filling material (glass or quartz powder) to prevent the ignition of an external explosive atmosphere. (CMP-14)
- Informational Note: See ANSI/UL 60079-5, *Explosive Atmospheres — Part 5: Equipment protection by powder filling “q”*, for additional information.
- Power Outlet.** An enclosed assembly that may include receptacles, circuit breakers, fuseholders, fused switches, buses, and watt-hour meter mounting means; intended to supply and control power to mobile homes, recreational vehicles, park trailers, or boats or to serve as a means for distributing power required to operate mobile or temporarily installed equipment. (CMP-7)
- Power Outlet, Marina. (Marina Power Outlet)** An enclosed assembly that can include equipment such as receptacles, circuit breakers, fused switches, fuses, watt-hour meters, panelboards, and monitoring means identified for marina use. (555) (CMP-7)
- Power Production Equipment.** Electrical generating equipment supplied by any source other than a utility service, up to the source system disconnecting means. (CMP-4)
- Informational Note: Examples of power production equipment include such items as generators, solar photovoltaic systems, and fuel cell systems.
- Power Source Output Conductors.** The conductors between power production equipment and the service or other premises wiring. (CMP-4)
- Power Supply.** A Class 2 power supply connected between the branch-circuit power distribution system and the busbar low-voltage suspended ceiling power distribution system. (393) (CMP-18)

N Power-Supply Cord. An assembly consisting of an attachment plug and a length of flexible cord connected to utilization equipment. (CMP-6)

N Premises. The land and buildings located on the user's side of the point of demarcation between the communications service provider and the user. (800) (CMP-16)

N Premises-Powered. Using power provided locally from the premises. (CMP-16)

Premises Wiring (System). Interior and exterior wiring, including power, lighting, control, and signal circuit wiring together with all their associated hardware, fittings, and wiring devices, both permanently and temporarily installed. This includes **one** of the following:

- (1) Wiring from the service point or power source to the outlets
- (2) Wiring from and including the power source to the outlets where there is no service point

Such wiring does not include wiring internal to appliances, luminaires, motors, controllers, motor control centers, and similar equipment. (CMP-1)

Informational Note: Power sources include, but are not limited to, interconnected or stand-alone batteries, solar photovoltaic systems, other distributed generation systems, or generators.

Δ Pressurized. The process of supplying an enclosure with a protective gas with or without continuous flow at sufficient pressure to prevent the entrance of combustible dust or ignitable fibers/flyings. (CMP-14)

Δ Pressurized Enclosure “p”. Type of protection for electrical equipment that uses the technique of guarding against the ingress of the external atmosphere, which **might** be explosive, into an enclosure by maintaining a protective gas therein at a pressure above that of the external atmosphere. (CMP-14)

Informational Note: See ANSI/UL-60079-2, *Explosive Atmospheres — Part 2: Equipment protection by pressurized enclosures “p”*, for additional information.

N Pressurized Room “p”. A room volume protected by pressurization and of sufficient size to permit the entry of a person who might occupy the room. (CMP-14)

Informational Note: See ANSI/UL 60079-13, *Explosive Atmospheres — Part 13: Equipment protection by pressurized room “p” and artificially ventilated room “v”*, for information on the requirements for rooms intended for human entry where pressurization is used as a means of reducing the risk of explosion.

N Primary Pad. A device external to the EV that transfers power via the contactless coupling as part of a wireless power transfer system. (625) (CMP-12)

N Primary Source. An electric utility or another source of power that acts as the main forming and stabilizing source in an electric power system. (CMP-4)

Prime Mover. The machine that supplies the mechanical horsepower to a generator. (CMP-13)

Process Seal. A seal between electrical systems and flammable or combustible process fluids where a failure could allow the migration of process fluids into the premises' wiring system. (CMP-14)

Informational Note: See ANSI/UL 122701, *Requirements for Process Sealing Between Electrical Systems and Flammable or Combustible Process Fluids*, for additional information.

N Production Areas. Areas where portable electrical equipment is used to implement the capture of images. (530) (CMP-15)

N Projector, Nonprofessional. (Nonprofessional Projector) Those types of projectors that do not comply with the definition of *Professional-Type Projector*. (540) (CMP-15)

N Projector, Professional-Type. (Professional-Type Projector) A type of projector using 35- or 70-mm film that has a minimum width of 35 mm (1 $\frac{3}{8}$ in.) and has on each edge 212 perforations per meter (5.4 perforations per inch), or a type using carbon arc, xenon, or other light source equipment that develops hazardous gases, dust, or radiation. (540) (CMP-15)

N Proscenium. The wall and arch that separates the stage from the auditorium (i.e., house). (520) (CMP-15)

Δ Protection by Enclosure “t”. Type of protection for explosive dust atmospheres where electrical equipment is provided with an enclosure providing dust ingress protection and a means to limit surface temperatures. (CMP-14)

Informational Note: See ANSI/UL 60079-31, *Explosive Atmospheres — Part 31: Equipment Dust Ignition Protection by Enclosure “t”*, for additional information.

N Psychiatric Hospital. A building used exclusively for the psychiatric care, on a 24-hour basis, of four or more inpatients. (517) (CMP-15)

Δ Purged and Pressurized. The process of (1) purging, supplying an enclosure with a protective gas at a sufficient flow and positive pressure to reduce the concentration of any flammable gas or vapor initially present to an acceptable level; and (2) pressurization, supplying an enclosure with a protective gas with or without continuous flow at sufficient pressure to prevent the entrance of a flammable gas or vapor, a combustible dust, or an ignitable fiber. (CMP-14)

Informational Note: See NFPA 496, *Standard for Purged and Pressurized Enclosures for Electrical Equipment*, for additional information.

N Purpose-Built. A custom luminaire, a piece of lighting equipment, or an effect that is constructed for a specific purpose and is not serially manufactured or available for general sale. (530) (CMP-15)

N PV DC Circuit (PV System DC Circuit). Any dc conductor in PV source circuits, PV string circuits, and PV dc-to-dc converter circuits. (690) (CMP-4)

N PV DC Circuit, Source. (PV Source Circuit) The PV dc circuit conductors between modules in a PV string circuit, and from PV string circuits or dc combiners, to dc combiners, electronic power converters, or a dc PV system disconnecting means. (690) (CMP-4)

N PV DC Circuit, String. (PV String Circuit) The PV source circuit conductors of one or more series-connected PV modules. (690) (CMP-4)

N PV Module (Module). A complete, environmentally protected unit consisting of solar cells and other components designed to produce dc power. (CMP-4)

PV (Photovoltaic) System (PV System) (Photovoltaic System). The total components, circuits, and equipment up to and including the PV system disconnecting means that, in combination, convert solar energy into electric energy. (CMP-4)

Qualified Person. One who has skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training to recognize and avoid the hazards involved. (CMP-1)

Informational Note: See NFPA 70E-2021, *Standard for Electrical Safety in the Workplace*, for electrical safety training requirements.

▲ Raceway. An enclosed channel designed expressly for holding wires, cables, or busbars, with additional functions as permitted in this *Code*. (CMP-8)

N Raceway Cell. A single enclosed tubular space in a cellular metal or concrete floor member, the axis of the cell being parallel to the axis of the floor member. (CMP-8)

N Raceway, Cellular Metal Floor. (Cellular Metal Floor Raceway) The hollow spaces of cellular metal floors, together with suitable fittings, that may be approved as enclosed channel for electrical conductors. (CMP-8)

Raceway, Communications. (Communications Raceway) An enclosed channel of nonmetallic materials designed expressly for holding communications wires and cables; optical fiber cables; data cables associated with information technology and communications equipment; Class 2, Class 3, and Type PLTC cables; and power-limited fire alarm cables in plenum, riser, and general-purpose applications. (CMP-16)

N Raceway, Strut-Type Channel. (Strut-Type Channel Raceway) A metal raceway that is intended to be mounted to the surface of or suspended from a structure, with associated accessories for the installation of electrical conductors and cables. (CMP-8)

N Raceway, Surface Metal. (Surface Metal Raceway) A metal raceway that is intended to be mounted to the surface of a structure, with associated couplings, connectors, boxes, and fittings for the installation of electrical conductors. (CMP-8)

N Raceway, Surface Nonmetallic. (Surface Nonmetallic Raceway) A nonmetallic raceway that is intended to be mounted to the surface of a structure, with associated couplings, connectors, boxes, and fittings for the installation of electrical conductors. (CMP-8)

N Raceway, Underfloor. (Underfloor Raceway) A raceway and associated components designed and intended for installation beneath or flush with the surface of a floor for the installation of cables and electrical conductors. (CMP-8)

N Rail. The structural support for the suspended ceiling system typically forming the ceiling grid supporting the ceiling tile and listed utilization equipment, such as sensors, actuators, A/V devices, and low-voltage luminaires and similar electrical equipment. (393) (CMP-18)

Rainproof. Constructed, protected, or treated so as to prevent rain from interfering with the successful operation of the apparatus under specified test conditions. (CMP-1)

Raintight. Constructed or protected so that exposure to a beating rain will not result in the entrance of water under specified test conditions. (CMP-1)

N Rated-Load Current (RLC). The current of a hermetic refrigerant motor-compressor resulting when it is operated at the rated load, rated voltage, and rated frequency of the equipment it serves. (440) (CMP-11)

N Rated Output Power. The amplifier manufacturer's stated or marked output power capability into its rated load. (640) (CMP-12)

N Rated Power. The output power of a wind turbine at its rated wind speed. (694) (CMP-4)

Informational Note: See IEC 61400-12-1, *Power Performance Measurements of Electricity Producing Wind Turbines*, for the method for measuring wind turbine power output.

Receptacle. A contact device installed at the outlet for the connection of an attachment plug, or for the direct connection of electrical utilization equipment designed to mate with the corresponding contact device. A single receptacle is a single contact device with no other contact device on the same yoke or strap. A multiple receptacle is two or more contact devices on the same yoke or strap. (CMP-18)

Informational Note: A duplex receptacle is an example of a multiple receptacle that has two receptacles on the same yoke or strap.

N Receptacle, Weight-Supporting Ceiling (WSCR). (Weight-Supporting Ceiling Receptacle) A contact device installed at an outlet box for the connection and support of luminaires or ceiling-suspended (paddle) fans using a weight-supporting attachment fitting (WSAF). (CMP-18)

Informational Note: See ANSI/NEMA WD 6, *American National Standard for Wiring Devices — Dimensional Specifications*, for the standard configuration of weight-supporting ceiling receptacles and related weight-supporting attachment fittings.

Receptacle Outlet. An outlet where one or more receptacles are installed. (CMP-18)

Reconditioned. Electromechanical systems, equipment, apparatus, or components that are restored to operating conditions. This process differs from normal servicing of equipment that remains within a facility, or replacement of listed equipment on a one-to-one basis. (CMP-1)

Informational Note: The term *reconditioned* is frequently referred to as *rebuild*, *refurbished*, or *remanufactured*.

N Recreational Vehicle (RV) (Camping Trailer) (Motor Home) (Travel Trailer) (Truck Camper). A vehicle or slide-in camper that is primarily designed as temporary living quarters for recreational, camping, or seasonal use; has its own motive power or is mounted on or towed by another vehicle; is regulated by the National Highway Traffic Safety Administration as a vehicle or vehicle equipment; does not require a special highway use permit for operation on the highways; and can be easily transported and set up on a daily basis by an individual. [1192:3.3.52] (551) (CMP-7)

Informational Note: See NFPA 1192, *Standard on Recreational Vehicles*, Informative Annex A, for product types and definitions for motor homes and towable recreational vehicles.

N Recreational Vehicle Park. Any parcel or tract of land under the control of any person, organization, or governmental entity wherein two or more recreational vehicle, recreational park trailer, and/or other camping sites are offered for use by the

public or members of an organization for overnight stays. (551) (CMP-7)

N Recreational Vehicle Site. A specific area within a recreational vehicle park or campground that is set aside for use by a camping unit. (551) (CMP-7)

N Recreational Vehicle Site Supply Equipment. A power outlet assembly located near the point of entrance of supply conductors to a recreational vehicle site and intended to constitute the disconnecting means for connected recreational vehicles. (551) (CMP-7)

N Recreational Vehicle Stand. That area of a recreational vehicle site intended for the placement of a recreational vehicle. (551) (CMP-7)

N Reference Grounding Point. The ground bus of the panel-board or isolated power system panel supplying the patient care room. [99:3.3.158] (517) (CMP-15)

N Relative Analgesia. A state of sedation and partial block of pain perception produced in a patient by the inhalation of concentrations of nitrous oxide insufficient to produce loss of consciousness (conscious sedation). (517) (CMP-15)

N Relay, Automatic Load Control. (Automatic Load Control Relay) An emergency lighting control device used to set normally dimmed or normally-off switched emergency lighting equipment to full power illumination levels in the event of a loss of the normal supply by bypassing the dimming/switching controls, and to return the emergency lighting equipment to normal status when the device senses the normal supply has been restored. (700) (CMP-13)

Informational Note: See ANSI/UL 924, *Emergency Lighting and Power Equipment*, for the requirements covering automatic load control relays.

Remote-Control Circuit. Any electrical circuit that controls any other circuit through a relay or an equivalent device. (CMP-3)

N Remote Disconnect Control. An electric device and circuit that controls a disconnecting means through a relay or equivalent device. (645) (CMP-12)

N Resistance Heating Element. A specific separate element to generate heat that is stand-alone, externally attached to, embedded in, integrated with, or internal to the object to be heated. (CMP-17)

Informational Note: Tubular heaters, strip heaters, heating cable, heating tape, heating blankets, immersion heaters, and heating panels are examples of resistance heaters.

N Restricted Industrial Establishment [as applied to hazardous (classified) locations]. Establishment with restricted public access, where the conditions of maintenance and supervision ensure that only qualified persons service the installation. (CMP-14)

Δ Retrofit Kit. A complete subassembly of parts and devices for field conversion of utilization equipment. (CMP-18)

N Retrofit Kit, General Use. (General Use Retrofit Kit) A kit consisting of primary parts, which does not include all the parts for a complete subassembly but includes a list of required parts and installation instructions to complete the subassembly in the field. (600) (CMP-18)

N Retrofit Kit, Sign Specific. (Sign Specific Retrofit Kit) A kit consisting of the necessary parts and hardware to allow for field installation in a host sign, based on the included installation instructions. (600) (CMP-18)

N Reverse Polarity Protection (Backfeed Protection). A system that prevents two interconnected power supplies, connected positive to negative, from passing current from one power source into a second power source. (393) (CMP-18)

N Ride Device. A device or combination of devices that carry, convey, or direct a person(s) over or through a fixed or restricted course within a defined area for the primary purpose of amusement or entertainment. (522) (CMP-15)

N Riser Cable, Cable Routing Assemblies, and Raceways. Cables, cable routing assemblies, and raceways that have fire-resistant characteristics capable of preventing the carrying of fire from floor to floor and are suitable for use in a vertical run in a shaft or from floor to floor. (722) (CMP-3)

N Safe Zone. Low probability of damage other than a slight swelling of the capacitor case, as identified by the case rupture curve of the capacitor. (460) (CMP-11)

N Safety Circuit. The part of a control system containing one or more devices that perform a safety-related function. [79:3.3.95] (CMP-12)

Informational Note: See NFPA 79-2021, *Electrical Standard for Industrial Machinery*. *Safety-related control system* and *safety interlock circuit* are common terms that can be used to refer to the safety circuit in other standards. The safety circuit can include hard-wired, communication, and software-related components.

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. (CMP-1)

Informational Note: The equipment may or may not be operable without opening the enclosure.

N Sealed [as applied to hazardous (classified) locations]. Constructed such that equipment is sealed effectively against entry of an external atmosphere and is not opened during normal operation or for any maintenance activities. (CMP-14)

Informational Note: See ANSI/UL 121201, *Nonincendive Electrical Equipment for Use in Class I and II, Division 2 and Class III, Divisions 1 and 2 Hazardous (Classified) Locations*, for additional information.

Δ Sealed, Hermetically. (Hermetically Sealed) Sealed against the entrance of an external atmosphere, such that the seal is made by fusion of metal to metal, ceramic to metal, or glass to metal. (CMP-14)

Informational Note: See ANSI/UL 121201, *Nonincendive Electrical Equipment for Use in Class I and II, Division 2 and Class III, Divisions 1 and 2 Hazardous (Classified) Locations*, for additional information.

N Section Sign. A sign or outline lighting system, shipped as subassemblies, that requires field-installed wiring between the subassemblies to complete the overall sign. The subassemblies are either physically joined to form a single sign unit or are installed as separate remote parts of an overall sign. (600) (CMP-18)

N Selected Receptacles. A minimal number of receptacles selected by the health care facility's governing body as necessary to provide essential patient care and facility services during loss of normal power. [99:3.3.164] (517) (CMP-15)

N Self-Contained Therapeutic Tubs or Hydrotherapeutic Tanks. A factory-fabricated unit consisting of a therapeutic tub or hydrotherapeutic tank with all water-circulating, heating, and control equipment integral to the unit. Equipment may include pumps, air blowers, heaters, light controls, sanitizer generators, and so forth. (680) (CMP-17)

N Separable Power Supply Cable Assembly. A flexible cord or cable, including ungrounded, grounded, and equipment grounding conductors, provided with a cord connector, an attachment plug, and all other fittings, grommets, or devices installed for the purpose of delivering energy from the source of electrical supply to the truck or transport refrigerated unit (TRU) flanged surface inlet. (626) (CMP-12)

Separately Derived System. An electrical power supply output, other than a service, having no direct connection(s) to circuit conductors of any other electrical source other than those established by grounding and bonding connections. (CMP-5)

Service. The conductors and equipment connecting the serving utility to the wiring system of the premises served. (CMP-10)

Service Conductors. The conductors from the service point to the service disconnecting means. (CMP-10)

Service Conductors, Overhead. (Overhead Service Conductors) The overhead conductors between the service point and the first point of connection to the service-entrance conductors at the building or other structure. (CMP-10)

Service Conductors, Underground. (Underground Service Conductors) The underground conductors between the service point and the first point of connection to the service-entrance conductors in a terminal box, meter, or other enclosure, inside or outside the building wall. (CMP-10)

Informational Note: Where there is no terminal box, meter, or other enclosure, the point of connection is considered to be the point of entrance of the service conductors into the building.

Service Drop. The overhead conductors between the serving utility and the service point. (CMP-10)

N Service-Entrance Conductor Assembly. Multiple single-insulated conductors twisted together without an overall covering, other than an optional binder intended only to keep the conductors together. (CMP-6)

Δ Service-Entrance Conductors. The service conductors between the terminals of the service equipment to the service drop, overhead service conductors, service lateral, or underground service conductors. (CMP-10)

Informational Note: Where service equipment is located outside the building walls, there could be no service-entrance conductors or they might be entirely outside the building.

Service Equipment. The necessary equipment, consisting of a circuit breaker(s) or switch(es) and fuse(s) and their accessories, connected to the serving utility and intended to constitute the main control and disconnect of the serving utility. (CMP-10)

N Service Equipment, Mobile Home. (Mobile Home Service Equipment) The equipment containing the disconnecting means, overcurrent protective devices, and receptacles or other means for connecting a mobile home feeder assembly. (550) (CMP-7)

Service Lateral. The underground conductors between the utility electric supply system and the service point. (CMP-10)

Service Point. The point of connection between the facilities of the serving utility and the premises wiring. (CMP-10)

Informational Note: The service point can be described as the point of demarcation between where the serving utility ends and the premises wiring begins. The serving utility generally specifies the location of the service point based on the conditions of service.

N Servicing. The process of following a manufacturer's set of instructions or applicable industry standards to analyze, adjust, or perform prescribed actions upon equipment with the intention to preserve or restore the operational performance of the equipment. (CMP-1)

Informational Note: Servicing often encompasses maintenance and repair activities.

N Shore Power. The electrical equipment required to power a floating vessel including, but not limited to, the receptacle and cords. (555) (CMP-7)

N Shoreline. The farthest extent of standing water under the applicable conditions that determine the electrical datum plane for the specified body of water. (682) (CMP-17)

N Short Circuit. An abnormal connection (including an arc) of relatively low impedance, whether made accidentally or intentionally, between two or more points of different potential. (CMP-10)

Short-Circuit Current Rating. The prospective symmetrical fault current at a nominal voltage to which an apparatus or system is able to be connected without sustaining damage exceeding defined acceptance criteria. (CMP-10)

Show Window. Any window, including windows above doors, 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. (CMP-2)

N Sign, Photovoltaic (PV) Powered (PV Powered Sign). [Photovoltaic (PV) Powered Sign] A complete sign powered by solar energy consisting of all components and subassemblies for installation either as an off-grid stand-alone, on-grid interactive, or non-grid interactive system. (600) (CMP-18)

N Sign Body. A portion of a sign that may provide protection from the weather but is not an electrical enclosure. (600) (CMP-18)

Signaling Circuit. Any electrical circuit that energizes signaling equipment. (CMP-3)

Δ Simple Apparatus. An electrical component or combination of components of simple construction with well-defined electrical parameters that does not generate more than 1.5 volts, 100 mA, and 25 mW, or a passive component that does not dissipate more than 1.3 watts and is compatible with the intrinsic safety of the circuit in which it is used. (CMP-14)

Informational Note No. 1: The following are examples of simple apparatus:

- (1) Passive components; for example, switches, instrument connectors, plugs and sockets, junction boxes, resistance temperature devices, and simple semiconductor devices such as LEDs
- (2) Sources of stored energy consisting of single components in simple circuits with well-defined parameters; for example, capacitors or inductors, whose values are considered when determining the overall safety of the system
- (3) Sources of generated energy; for example, thermocouples and photocells, that do not generate more than 1.5 volts, 100 mA, and 25 mW

Informational Note No. 2: See ANSI/UL 913, *Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations*, and ANSI/UL 60079-11, *Explosive Atmospheres — Part 11: Equipment Protection by Intrinsic Safety “i”*, for additional information.

Single-Pole Separable Connector. A device that is installed at the ends of portable, flexible, single-conductor cable that is used to establish connection or disconnection between two cables or one cable and a single-pole, panel-mounted separable connector. (CMP-18)

Site-Isolating Device. A pole-mounted disconnecting means installed at the distribution point for the purposes of isolation, system maintenance, emergency disconnection, or connection of optional standby systems. (547) (CMP-7)

Skeleton Tubing. Neon tubing that is itself the sign or outline lighting and is not attached to an enclosure or sign body. (600) (CMP-18)

Slip. A berthing space between or adjacent to piers, wharves, or docks; the water areas associated with boat occupation. [303:3.3.21] (555) (CMP-7)

Informational Note: See the definition of *Berth* for additional information.

Solid-State Phase-Control Dimmer. A solid-state dimmer where the wave shape of the steady-state current does not follow the wave shape of the applied voltage such that the wave shape is nonlinear. (CMP-15)

Solid-State Sine Wave Dimmer. A solid-state dimmer where the wave shape of the steady-state current follows the wave shape of the applied voltage such that the wave shape is linear. (CMP-15)

Spa or Hot Tub. A hydromassage pool, or tub for recreational or therapeutic use, not located in health care facilities, designed for immersion of users, and usually having a filter, heater, and motor-driven blower. It may be installed indoors or outdoors, on the ground or supporting structure, or in the ground or supporting structure. Generally, they are not designed or intended to have its contents drained or discharged after each use. (680) (CMP-17)

Spa or Hot Tub, Packaged Equipment Assembly. (Packaged Spa or Hot Tub Equipment Assembly) A factory-fabricated unit consisting of water-circulating, heating, and control equipment mounted on a common base, intended to operate a spa or hot tub. Equipment can include pumps, air blowers, heaters, lights, controls, sanitizer generators, and so forth. (680) (CMP-17)

Spa or Hot Tub, Self-Contained. (Self-Contained Spa or Hot Tub) Factory-fabricated unit consisting of a spa or hot tub vessel with all water-circulating, heating, and control equip-

ment integral to the unit. Equipment can include pumps, air blowers, heaters, lights, controls, sanitizer generators, and so forth. (680) (CMP-17)

Spa or Hot Tub, Storable. (Storable Spa or Hot Tub) Spas or hot tubs installed entirely on or above the ground that are intended to be stored when not in use and are designed for ease of relocation. (680) (CMP-17)

Space. A portion of the health care facility designated by the health care facility's governing body that serves a specific purpose. [99:3.3.171] (517) (CMP-15)

Special Permission. The written consent of the authority having jurisdiction. (CMP-1)

Special Protection “s”. Type of protection that permits design, assessment, and testing of equipment that cannot be fully assessed within a recognized type of protection or combination of recognized types of protection because of functional or operational limitations, but that can be demonstrated to provide the necessary equipment protection level (EPL). (CMP-14)

Informational Note: See ANSI/UL 60079-33, *Explosive Atmospheres — Part 33: Equipment Protection by Special Protection “s”*, for additional information.

Special-Purpose Multi-Circuit Cable System. A portable branch-circuit distribution system consisting of one or more trunk cables and optional breakout assemblies or multi-circuit outlet enclosures. (520) (CMP-15)

Spider (Cable Splicing Block). A device that contains busbars that are insulated from each other for the purpose of splicing or distributing power to portable cables and cords that are terminated with single-pole busbar connectors. (530) (CMP-15)

Spin Down. A shutdown condition of the FESS, where energy is being dissipated and the flywheel rotor is slowing down to a stop. (706) (CMP-13)

Informational Note: A complete stop of a flywheel rotor cannot occur instantaneously because of the high kinetic energy of the rotor, but rather occurs over time as a result of friction forces acting on the rotor.

Splash Pad. A fountain intended for recreational use by pedestrians and designed to contain no more than 25 mm (1 in.) of water depth. This definition does not include showers intended for hygienic rinsing prior to use of a pool, spa, or other water feature. (680) (CMP-17)

Spray Area. Any fully enclosed, partly enclosed, or unenclosed area in which flammable or combustible vapors, mists, residues, dusts, or deposits are present due to the operation of spray processes, including:

- (1) any area in the direct path of a spray application process;
- (2) the interior of a spray booth, spray room, or limited finishing workstation, as herein defined;
- (3) the interior of any exhaust plenum, eliminator section, or scrubber section;
- (4) the interior of any exhaust duct or exhaust stack leading from a spray application process;
- (5) the interior of any air recirculation path up to and including recirculation particulate filters;
- (6) any solvent concentrator (pollution abatement) unit or solvent recovery (distillation) unit; and

- (7) the inside of a membrane enclosure.

The following are not part of the spray area:

- (1) fresh air make-up units;
- (2) air supply ducts and air supply plenums;
- (3) recirculation air supply ducts downstream of recirculation particulate filters; and
- (4) exhaust ducts from solvent concentrator (pollution abatement) units. [33:3.3.2.3] (CMP-14)

Informational Note No. 1: Unenclosed spray areas are locations outside of buildings or are localized operations within a larger room or space. Such areas are normally provided with some local vapor extraction/ventilation system. In automated operations, the area limits are the maximum area in the direct path of spray operations. In manual operations, the area limits are the maximum area of spray when aimed at 90 degrees to the application surface.

Informational Note No. 2: See definitions for *limited finishing workstation* and *membrane enclosure* for additional information.

Spray Area, Outdoor. (Outdoor Spray Area) A spray area that is outside the confines of a building or that has a canopy or roof that does not limit the dissipation of the heat of a fire or dispersion of flammable vapors and does not restrict fire-fighting access and control. For the purpose of this standard, an outdoor spray area can be treated as an unenclosed spray area as defined in this *Code*. [33:3.3.2.3.1] (CMP-14)

Spray Area, Unenclosed. (Unenclosed Spray Area) Any spray area that is not confined by a limited finishing workstation, spray booth, or spray room, as herein defined. [33:3.3.2.3.2] (CMP-14)

Spray Booth. A power-ventilated enclosure for a spray application operation or process that confines and limits the escape of the material being sprayed, including vapors, mists, dusts, and residues that are produced by the spraying operation and conducts or directs these materials to an exhaust system. [33:3.3.19] (CMP-14)

Informational Note: A spray booth is an enclosure or insert within a larger room used for spraying, coating, and/or dipping applications. A spray booth can be fully enclosed or have open front or face and can include a separate conveyor entrance and exit. The spray booth is provided with a dedicated ventilation exhaust with supply air from the larger room or from a dedicated air supply.

Spray Room. A power-ventilated fully enclosed room with a specified fire resistance rating used exclusively for open spraying of flammable or combustible materials. [33:3.3.20] (CMP-14)

N Stage Effect (Special Effect). An electrical or electromechanical piece of equipment used to simulate a distinctive visual or audible effect, such as a wind machine, lightning simulator, or sunset projector. (CMP-15)

N Stage Equipment. Equipment at any location on the premises integral to the stage production including, but not limited to, equipment for lighting, audio, special effects, rigging, motion control, projection, or video. (520) (CMP-15)

N Stage Lighting Hoist. A motorized lifting device that contains a mounting position for one or more luminaires, with wiring devices for connection of luminaires to branch circuits, and integral flexible cables to allow the luminaires to travel over the lifting range of the hoist while energized. (520) (CMP-15)

N Stage Property. An article or object used as a visual element in a motion picture or television production, except painted backgrounds (scenery) and costumes. (530) (CMP-15)

N Stage Set. A specific area set up with temporary scenery and properties designed and arranged for a particular scene in a motion picture or television production. (CMP-15)

N Stage Switchboard, Fixed. (Fixed Stage Switchboard) A permanently installed switchboard, panelboard, or rack containing dimmers or relays with associated overcurrent protective devices, or overcurrent protective devices alone, used primarily to feed stage equipment. (CMP-15)

N Stage Switchboard, Portable. (Portable Stage Switchboard) A portable rack or pack containing dimmers or relays with associated overcurrent protective devices, or overcurrent protective devices alone, used to feed stage equipment. (520) (CMP-15)

N Stand Lamp. A portable stand that contains a general-purpose luminaire or lampholder with guard for the purpose of providing general illumination on a stage, in an auditorium, or in a studio. (520) (CMP-15)

Stand-Alone System. A system that is not connected to an electric power production and distribution network. (CMP-4)

N Stationary (as applied to equipment). Equipment that is not moved from one place to another in normal use. (680) (CMP-17)

N Storage, Dry Stack. (Dry Stack Storage) A facility, either covered or uncovered, constructed of horizontal and vertical structural members designed to allow placement of small boats in defined slots arranged both horizontally and vertically. [303:3.3.24.2] (555) (CMP-7)

N Stored-Energy Power Supply System (SEPPS). A complete functioning EPSS powered by a stored-energy electrical source. (CMP-13)

N Stranding, Compact. (Compact Stranding) A conductor stranding method in which each layer of strands is pressed together to minimize the gaps between the strands so the overall diameter of the finished conductor is less than a concentric stranded conductor and less than a compressed stranded conductor. (CMP-6)

N Stranding, Compressed. (Compressed Stranding) A conductor stranding method in which the outer layer of strands is pressed together so the overall diameter of the finished conductor is less than a concentric stranded conductor but greater than a compact stranded conductor. (CMP-6)

N Stranding, Concentric. (Concentric Stranding) A conductor consisting of a straight central strand surrounded by one or more layers of strands, helically laid in a geometric pattern. (CMP-6)

N Strip Light. A luminaire with multiple lamps arranged in a row. (520) (CMP-15)

Structure. That which is built or constructed, other than equipment. (CMP-1)

N Structure, Relocatable. (Relocatable Structure) A factory-assembled structure or structures transportable in one or more sections that are built on a permanent chassis and designed to be used as other than a dwelling unit without a permanent foundation. (545) (CMP-7)

Informational Note: Examples of relocatable structures are those units that are equipped for sleeping purposes only, contractor's and other on-site offices, construction job dormitories, studio dressing rooms, banks, clinics, stores, shower facilities and restrooms, training centers, or for the display or demonstration of merchandise or machines.

Subassembly. Component parts or a segment of a sign, retrofit kit, or outline lighting system that, when assembled, forms a complete unit or product. (600) (CMP-18)

Substation. An assemblage of equipment (e.g., switches, interrupting devices, circuit breakers, buses, and transformers) through which electric energy is passed for the purpose of distribution, switching, or modifying its characteristics. (CMP-9)

Supervisory Control and Data Acquisition (SCADA). An electronic system that provides monitoring and controls for the operation of the critical operations power system. (CMP-13)

Informational Note: This can include the fire alarm system, security system, control of the HVAC, the start/stop/monitoring of the power supplies and electrical distribution system, annunciation and communications equipment to emergency personnel, facility occupants, and remote operators.

Support Areas. Areas, other than fixed production offices, intended to support production and where image capture will not take place. Such areas include, but are not limited to, mobile production offices, storage, and workspaces; vehicles and trailers for cast, makeup, hair, lighting, grip, wardrobe, props, catering, and craft services; and portable restrooms. (530) (CMP-15)

Surge Arrester. A protective device for limiting surge voltages by discharging or bypassing surge current; it also prevents continued flow of follow current while remaining capable of repeating these functions. (CMP-10)

Surge-Protective Device (SPD). A protective device for limiting transient voltages by diverting or limiting surge current; it also prevents continued flow of follow current while remaining capable of repeating these functions and is designated as follows:

- (1) Type 1: Permanently connected SPDs intended for installation between the secondary of the service transformer and the line side of the service disconnect overcurrent device
- (2) Type 2: Permanently connected SPDs intended for installation on the load side of the service disconnect overcurrent device, including SPDs located at the branch panel
- (3) Type 3: Point of utilization SPDs
- (4) Type 4: Component SPDs, including discrete components, as well as assemblies. (CMP-10)

Informational Note: See UL 1449, *Standard for Surge Protective Devices*, for further information on SPDs.

Suspended Ceiling Grid. A system that serves as a support for a finished ceiling surface and other utilization equipment. (393) (CMP-18)

Switch, General-Use. (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. (CMP-9)

Switch, General-Use Snap. (General-Use Snap Switch) A form of general-use switch constructed so that it can be installed in

device boxes or on box covers, or otherwise used in conjunction with wiring systems recognized by this *Code*. (CMP-9)

Switch, Isolating. (Isolating Switch) A switch intended for isolating an electrical 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. (CMP-9)

Switch, Motor-Circuit. (Motor-Circuit Switch) A switch rated in horsepower that is capable of interrupting the maximum operating overload current of a motor of the same horsepower rating as the switch at the rated voltage. (CMP-11)

Switchboard. A large single panel, frame, or assembly of panels on which are mounted on the face, back, or both, switches, overcurrent and other protective devices, buses, and usually instruments. (CMP-9)

Informational Note: These assemblies can be accessible from the rear or side as well as from the front and are not intended to be installed in cabinets.

Switchgear. An assembly completely enclosed on all sides and top with sheet metal (except for ventilating openings and inspection windows) and containing primary power circuit switching, interrupting devices, or both, with buses and connections. The assembly may include control and auxiliary devices. Access to the interior of the enclosure is provided by doors, removable covers, or both. (CMP-9)

Informational Note: All switchgear subject to *NEC* requirements is metal enclosed. Switchgear rated below 1000 V or less may be identified as "low-voltage power circuit breaker switchgear." Switchgear rated over 1000 V may be identified as "metal-enclosed switchgear" or "metal-clad switchgear." Switchgear is available in non-arc-resistant or arc-resistant constructions.

Switching Device(as applied to equipment rated over 1000 volts ac, 1500 volts dc, nominal). A device designed to close, open, or both, one or more electrical circuits. (CMP-9)

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

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

Oil-Filled Cutout. A cutout in which all or part of the fuse support and its fuse link or disconnecting blade is 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. A switching device having contacts that operate under oil (or askarel or other suitable liquid).

• **Regulator Bypass Switch.** A switching device or combination of switching devices designed to bypass equipment used to control voltage levels or related circuit characteristics.

• **System Isolation Equipment.** A redundantly monitored, remotely operated contactor-isolating system, packaged to

provide the disconnection/isolation function, capable of verifiable operation from multiple remote locations by means of lockout switches, each having the capability of being padlocked in the “off” (open) position. (430) (CMP-11)

N Tap Conductor. A conductor, other than a service conductor, that has overcurrent protection ahead of its point of supply that exceeds the value permitted for similar conductors that are protected as described elsewhere in 240.4. (240) (CMP-10)

N Task Illumination. Provisions for the minimum lighting required to carry out necessary tasks in the areas described in 517.34(A), including safe access to supplies and equipment and access to exits. [99:3.3.177] (517) (CMP-15)

N Technical Power System. An electrical distribution system where the equipment grounding conductor is isolated from the premises grounded conductor and the premises equipment grounding conductor except at a single grounded termination point within a branch-circuit panelboard, at the originating (main breaker) branch-circuit panelboard or at the premises grounding electrode. (640) (CMP-12)

N Temporary Equipment. Portable wiring and equipment intended for use with events of a transient or temporary nature where all equipment is presumed to be removed at the conclusion of the event. (640) (CMP-12)

N Terminal (as applied to batteries). That part of a cell, container, or battery to which an external connection is made (commonly identified as post, pillar, pole, or terminal post). (CMP-13)

Thermal Protector (as applied to motors). A protective device for assembly as an integral part of a motor or motor-compressor that, when properly applied, protects the motor against dangerous overheating due to overload and failure to start. (CMP-11)

Informational Note: The thermal protector may consist of one or more sensing elements integral with the motor or motor-compressor and an external control device.

N Thermal Resistivity. The heat transfer capability through a substance by conduction. (CMP-6)

Informational Note: Thermal resistivity is the reciprocal of thermal conductivity and is designated Rho, which is expressed in the units °C-cm/W.

Thermally Protected (as applied to motors). A motor or motor-compressor that is provided with a thermal protector. (CMP-11)

N Top Shield. A grounded metal shield covering under-carpet components of the flat conductor cable (Type FCC) system for the purposes of providing protection against physical damage. (324) (CMP-6)

N Tower. A pole or other structure that supports a wind turbine. (694) (CMP-4)

Transfer Switch. An automatic or nonautomatic device for transferring one or more load conductor connections from one power source to another. (CMP-13)

N Transfer Switch, Branch-Circuit Emergency Lighting. (Branch-Circuit Emergency Lighting Transfer Switch) A device connected on the load side of a branch-circuit overcurrent protective device that transfers only emergency lighting loads from the

normal power source to an emergency power source. (700) (CMP-13)

Informational Note: See ANSI/UL 1008, *Transfer Switch Equipment*, for information covering branch-circuit emergency lighting transfer switches.

Transfer Switch, Bypass Isolation. (Bypass Isolation Transfer Switch) A manual, nonautomatic, or automatic operated device used in conjunction with a transfer switch to provide a means of directly connecting load conductors to a power source and of disconnecting the transfer switch. (CMP-13)

N Transfer Switch, Meter-Mounted. (Meter-Mounted Transfer Switch) A transfer switch connected between the utility meter and the meter base. (CMP-13)

Informational Note: Meter-mounted transfer switches can plug into the meter base. Transfer switches that incorporate the meter base in the transfer equipment assembly are not considered meter-mounted transfer switches.

N Transformer. Equipment, either single-phase or polyphase, that uses electromagnetic induction to convert current and voltage in a primary circuit into current and voltage in a secondary circuit. (CMP-9)

N Transition Assembly. An assembly to facilitate connection of the flat conductor cable (Type FCC) system to other wiring systems, incorporating (1) a means of electrical interconnection and (2) a suitable box or covering for providing electrical safety and protection against physical damage. (324) (CMP-6)

N Transport Refrigerated Unit (TRU). A trailer or container, with integrated cooling or heating, or both, used for the purpose of maintaining the desired environment of temperature-sensitive goods or products. (626) (CMP-12)

N Transportable. X-ray equipment that is to be installed in a vehicle or that may be readily disassembled for transport in a vehicle. (660) (CMP-12)

N Truck. A motor vehicle designed for the transportation of goods, services, and equipment. (626) (CMP-12)

N Truck Coupler. A truck flanged surface inlet and mating cord connector. (626) (CMP-12)

N Truck Flanged Surface Inlet. The device(s) on the truck into which the connector(s) is inserted to provide electric energy and other services. This device is part of the truck coupler. For the purposes of this article, the truck flanged surface inlet is considered to be part of the truck and not part of the electrified truck parking space supply equipment. (626) (CMP-12)

N Trunk Cable. A portable extension cable containing six or more branch circuits, a male multipole plug, and a female multipole receptacle. (520) (CMP-15)

N Tubing, Electrical Metallic (EMT). (Electrical Metallic Tubing) An unthreaded thinwall raceway of circular cross section designed for the physical protection and routing of conductors and cables and for use as an equipment grounding conductor when installed utilizing appropriate fittings. (CMP-8)

N Tubing, Electrical Nonmetallic (ENT). (Electrical Nonmetallic Tubing) A nonmetallic, pliable, corrugated raceway of circular cross section with integral or associated couplings, connectors, and fittings for the installation of electrical conductors. It is composed of a material that is resistant to moisture and chemical atmospheres and is flame retardant.

A pliable raceway is a raceway that can be bent by hand with a reasonable force but without other assistance. (CMP-8)

N Tubing, Flexible Metallic (FMT). (Flexible Metallic Tubing) A metal raceway that is circular in cross section, flexible, and liquidtight without a nonmetallic jacket. (CMP-8)

N Two-Fer. An assembly containing one male plug and two female cord connectors used to connect two loads to one branch circuit. (520) (CMP-15)

Δ Type of Protection “n”. Type of protection where electrical equipment, in normal operation, is not capable of igniting a surrounding explosive gas atmosphere and a fault capable of causing ignition is not likely to occur. (CMP-14)

Informational Note: See ANSI/UL 60079-15, *Explosive Atmospheres — Part 15: Equipment Protection by Type of Protection “n”,* for additional information.

Ungrounded. Not connected to ground or to a conductive body that extends the ground connection. (CMP-5)

Δ Uninterruptible Power Supply (UPS). A device or system that provides quality and continuity of ac power through the use of a stored-energy device as the backup power source for a period of time when the normal power supply is incapable of performing acceptably. (CMP-13)

N Unit Equipment. A battery-equipped emergency luminaire that illuminates only as part of the emergency illumination system and is not illuminated when the normal supply is available. (CMP-13)

Utilization Equipment. Equipment that utilizes electric energy for electronic, electromechanical, chemical, heating, lighting, or similar purposes. (CMP-1)

N Valve Actuator Motor (VAM) Assemblies. A manufactured assembly, used to operate a valve, consisting of an actuator motor and other components such as motor controllers, torque switches, limit switches, and overload protection. (430) (CMP-11)

Informational Note: VAMs typically have short-time duty and high-torque characteristics.

Ventilated. Provided with a means to permit circulation of air sufficient to remove an excess of heat, fumes, or vapors. (CMP-14)

N Vessel. A container such as a barrel, drum, or tank for holding fluids or other material. (CMP-17)

Volatile Flammable Liquid. A flammable liquid having a flash point below 38°C (100°F), or a flammable liquid whose temperature is above its flash point, or a Class II combustible liquid that has a vapor pressure not exceeding 276 kPa (40 psia) at 38°C (100°F) and whose temperature is above its flash point. (CMP-14)

Voltage (of a circuit). The greatest root-mean-square (rms) (effective) difference of potential between any two conductors of the circuit concerned. (CMP-1)

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

N Voltage, High. (High Voltage) A potential difference of more than 1000 volts, nominal. (CMP-9)

Informational Note: Circuits and equipment rated at potential differences of more than 1000 volts and up to 52 kV are also commonly referred to as medium voltage.

N Voltage, Low. (Low Voltage). An electromotive force rated 24 volts, nominal, or less. (551) (CMP-7)

Δ Voltage, Nominal. (Nominal Voltage) A nominal value assigned to a circuit or system for the purpose of conveniently designating its voltage class (e.g., 120/240 volts, 480Y/277 volts, 600 volts). (CMP-1)

Informational Note No. 1: The actual voltage at which a circuit operates can vary from the nominal within a range that permits satisfactory operation of equipment.

Informational Note No. 2: See ANSI C84.1-2011, *Voltage Ratings for Electric Power Systems and Equipment* (60 Hz).

N Voltage, Nominal (as applied to battery or cell). (Nominal Voltage) The value assigned to a cell or battery of a given voltage class for the purpose of convenient designation. The operating voltage of the cell or battery may vary above or below this value. (CMP-13)

Informational Note: The most common nominal cell voltages are 2 volts per cell for the lead-acid batteries, 1.2 volts per cell for alkali batteries, and 3.2 to 3.8 volts per cell for Li-ion batteries. Nominal voltages might vary with different chemistries.

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. (CMP-1)

Watertight. Constructed so that moisture will not enter the enclosure under specified test conditions. (CMP-1)

Weatherproof. Constructed or protected so that exposure to the weather will not interfere with successful operation. (CMP-1)

Informational Note: 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.

N Wharf. A structure at the shoreline that has a platform built along and parallel to a body of water with either an open deck or a superstructure. [307:3.3.28] (555) (CMP-7)

N Wind Turbine. A mechanical device that converts wind energy to electrical energy. (CMP-4)

N Wind Turbine Output Circuit. (Turbine Output Circuit) The circuit conductors between the internal components of a wind turbine (which might include an alternator, integrated rectifier, controller, and/or inverter) and other equipment. (694) (CMP-4)

N Wire. A factory assembly of one or more insulated conductors without an overall covering. (805) (CMP-16)

N Wireless Power Transfer (WPT). The transfer of electrical energy from a power source to an electrical load via magnetic fields by a contactless means between a primary device and a secondary device. (625) (CMP-12)

N Wireless Power Transfer Equipment (WPTE). Equipment installed specifically for the purpose of transferring energy between the premises wiring and the electric vehicle without physical electrical contact. (625) (CMP-12)

Informational Note No. 1: The general form of WPTE consists of two physical packages: a control box and a primary pad.

Informational Note No. 2: Electric vehicle power export equipment and wireless power transfer equipment are sometimes contained in one set of equipment, sometimes referred to as a bidirectional WPTE.

W Wireways, Metal. (Metal Wireways) Sheet metal troughs with hinged or removable covers for housing and protecting electrical wires and cable and in which conductors are laid in place after the raceway has been installed as a complete system. (CMP-8)

W Wireways, Nonmetallic. (Nonmetallic Wireways) Flame-retardant, nonmetallic troughs with removable covers for housing and protecting electrical wires and cables in which conductors are laid in place after the raceway has been installed as a complete system. (CMP-8)

W Work Surface. A fixed, stationary, or portable surface typically intended for dry use and for tasks other than food preparation, personal lavation, or laundering that presents an incidental risk of spillage of smaller quantities of beverages and other liquids upon outlets mounted directly on or recessed in the surface. (CMP-2)

Informational Note No. 1: See UL 111, *Outline of Investigation for Multioutlet Assemblies*, and UL 962A, *Furniture Power Distribution Units*, which establish the performance evaluation criteria and construction criteria.

Informational Note No. 2: See 406.5(F), 406.5(G)(1), and 406.5(H) for information on receptacles for work surfaces distinguished from receptacles for counters and countertops.

W Zone. A physically identifiable area (such as barriers or separation by distance) within an information technology equipment room, with dedicated power and cooling systems for the information technology equipment or systems. (645) (CMP-12)

ARTICLE 110

General Requirements for Electrical Installations

Part I. General

110.1 Scope. This article covers general requirements for the examination and approval, installation and use, access to and spaces about electrical conductors and equipment; enclosures intended for personnel entry; and tunnel installations.

Informational Note: See Informative Annex J for information regarding ADA accessibility design.

110.2 Approval. The conductors and equipment required or permitted by this *Code* shall be acceptable only if approved.

Informational Note: See 90.7, Examination of Equipment for Safety, and 110.3, Examination, Identification, Installation, and Use of Equipment. See definitions of *Approved*, *Identified*, *Labeled*, and *Listed*.

110.3 Examination, Identification, Installation, Use, and Listing (Product Certification) of Equipment.

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

- (1) Suitability for installation and use in conformity with this *Code*

Informational Note No. 1: Equipment may be new, reconditioned, refurbished, or remanufactured.

Informational Note No. 2: Suitability of equipment use may be identified by a description marked on or provided with a product to identify the suitability of the product for a specific purpose, environment, or application. Special conditions of use or other limitations and other pertinent information may be marked on the equipment, included in the product instructions, or included in the appropriate listing and labeling information. Suitability of equipment may be evidenced by listing or labeling.

- (2) Mechanical strength and durability, including, for parts designed to enclose and protect other equipment, the adequacy of the protection thus provided
- (3) Wire-bending and connection space
- (4) Electrical insulation
- (5) Heating effects under normal conditions of use and also under abnormal conditions likely to arise in service
- (6) Arcing effects
- (7) Classification by type, size, voltage, current capacity, and specific use
- (8) Cybersecurity for network-connected life safety equipment to address its ability to withstand unauthorized updates and malicious attacks while continuing to perform its intended safety functionality

Informational Note No. 3: See the ANSI/ISA 62443 series of standards for industrial automation and control systems, the UL 2900 series of standards for software cybersecurity for network-connectable products, and UL 5500, *Standard for Remote Software Updates*, which are standards that provide frameworks to mitigate current and future security cybersecurity vulnerabilities and address software integrity in systems of electrical equipment.

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

(B) Installation and Use. Equipment that is listed, labeled, or both, or identified for a use shall be installed and used in accordance with any instructions included in the listing, labeling, or identification.

Informational Note: The installation and use instructions may be provided in the form of printed material, quick response (QR) code, or the address on the internet where users can download the required instructions.

(C) Listing. Product testing, evaluation, and listing (product certification) shall be performed by recognized qualified electrical testing laboratories and shall be in accordance with applicable product standards recognized as achieving equivalent and effective safety for equipment installed to comply with this *Code*.

Informational Note: The Occupational Safety and Health Administration (OSHA) recognizes qualified electrical testing laboratories that perform evaluations, testing, and certification of certain products to ensure that they meet the requirements of both the construction and general industry OSHA electrical standards. If the listing (product certification) is done under a

qualified electrical testing laboratory program, this listing mark signifies that the tested and certified product complies with the requirements of one or more appropriate product safety test standards.

110.4 Voltages. The voltage considered shall be that at which the circuit operates. The voltage rating of electrical equipment shall not be less than the nominal voltage of a circuit to which it is connected.

110.5 Conductors. Conductors used to carry current shall be of copper, aluminum, or copper-clad aluminum unless otherwise provided in this *Code*. If the conductor material is not specified, the sizes given in this *Code* shall apply to copper conductors. If other materials are used, the size shall be changed accordingly.

110.6 Conductor Sizes. Conductor sizes are expressed in American Wire Gauge (AWG) or in circular mils.

110.7 Wiring Integrity. Completed wiring installations shall be free from short circuits, ground faults, or any connections to ground other than as required or permitted elsewhere in this *Code*.

110.8 Wiring Methods. Only wiring methods recognized as suitable are included in this *Code*. The recognized methods of wiring shall be permitted to be installed in any type of building, occupancy, or premises wiring system, except as otherwise provided in this *Code*.

110.9 Interrupting Rating. Equipment intended to interrupt current at fault levels shall have an interrupting rating at nominal circuit voltage at least equal to the available fault current at the line terminals of the equipment.

Equipment intended to interrupt current at other than fault levels shall have an interrupting rating at nominal circuit voltage at least equal to the current that must be interrupted.

110.10 Circuit Impedance, Short-Circuit Current Ratings, and Other Characteristics. The overcurrent protective devices, the total impedance, the equipment short-circuit current ratings, and other characteristics of the circuit to be protected shall be selected and coordinated to permit the circuit protective devices used to clear a fault to do so without extensive damage to the electrical equipment of the circuit. This fault shall be assumed to be either between two or more of the circuit conductors or between any circuit conductor and the equipment grounding conductor(s) permitted in 250.118. Listed equipment applied in accordance with their listing shall be considered to meet the requirements of this section.

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

Informational Note No. 1: See 300.6 for protection against corrosion.

Informational Note No. 2: Some cleaning and lubricating compounds can cause severe deterioration of many plastic materials used for insulating and structural applications in equipment.

Equipment not identified for outdoor use and equipment identified only for indoor use, such as “dry locations,” “indoor

use only,” “damp locations,” or enclosure Types 1, 2, 5, 12, 12K, and/or 13, shall be protected against damage from the weather during construction.

Informational Note No. 3: See Table 110.28 for appropriate enclosure-type designations.

Informational Note No. 4: See NFPA 5000-2015, *Building Construction and Safety Code*, the *International Building Code (IBC)*, and the *International Residential Code for One- and Two-Family Dwellings (IRC)*, for information for minimum flood provisions.

110.12 Mechanical Execution of Work. Electrical equipment shall be installed in a professional and skillful manner.

Informational Note: See ANSI/NECA 1-2015, *Standard for Good Workmanship in Electrical Construction*, and other ANSI-approved installation standards for information on accepted industry practices.

(A) Unused Openings. Unused openings, other than those intended for the operation of equipment, those intended for mounting purposes, or those permitted as part of the design for listed equipment, shall be closed to afford protection substantially equivalent to the wall of the equipment. Where metallic plugs or plates are used with nonmetallic enclosures, they shall be recessed at least 6 mm (¼ in.) from the outer surface of the enclosure.

(B) Integrity of Electrical Equipment and Connections. Internal parts of electrical equipment, including busbars, wiring terminals, insulators, and other surfaces, shall not be damaged or contaminated by foreign materials such as paint, plaster, cleaners, abrasives, or corrosive residues. There shall be no damaged parts that may adversely affect safe operation or mechanical strength of the equipment such as parts that are broken; bent; cut; or deteriorated by corrosion, chemical action, or overheating.

Δ (C) Cables and Conductors. Cables and conductors installed exposed on the surfaces of ceilings and sidewalls shall be supported by the building structure in such a manner that the cables and conductors will not be damaged by normal building use. Such cables and conductors shall be secured by hardware including straps, staples, cable ties, hangers, or similar fittings designed and installed so as not to damage the cable. The installation shall also conform with 300.4 and 300.11. Nonmetallic cable ties and other nonmetallic cable accessories used to secure and support cables in other spaces used for environmental air (plenums) shall be listed as having low smoke and heat release properties.

Informational Note No. 1: See NFPA 90A-2021, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, 4.3.11.2.6.5 and 4.3.11.5.5.6, for discrete combustible components installed in accordance with 300.22(C).

Informational Note No. 2: Paint, plaster, cleaners, abrasives, corrosive residues, or other contaminants may result in an undetermined alteration of optical fiber cable properties.

110.13 Mounting and Cooling of Equipment.

(A) Mounting. Electrical equipment shall be firmly secured to the surface on which it is mounted. Wooden plugs driven into holes in masonry, concrete, plaster, or similar materials shall not be used.

(B) Cooling. Electrical equipment that depends on the natural circulation of air and convection principles for cooling of exposed surfaces shall be installed so that room airflow over

such surfaces is not prevented by walls or by adjacent installed equipment. For equipment designed for floor mounting, clearance between top surfaces and adjacent surfaces shall be provided to dissipate rising warm air.

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

Δ 110.14 Electrical Connections. Because of different characteristics of dissimilar metals, devices such as pressure terminal or pressure splicing connectors and soldering lugs shall be identified for the material of the conductor and shall be properly installed and used. Conductors of dissimilar metals shall not be intermixed in a terminal or splicing connector where physical contact occurs between dissimilar conductors unless the device is identified for the purpose and conditions of use. Materials such as solder, fluxes, inhibitors, and compounds, where employed, shall be suitable for the use and shall be of a type that will not adversely affect the conductors, installation, or equipment.

Connectors and terminals for conductors more finely stranded than Class B and Class C stranding as shown in Chapter 9, Table 10, shall be identified for the specific conductor class or classes.

(A) Terminals. Connection of conductors to terminal parts shall ensure a **mechanically secure electrical** connection without damaging the conductors and shall be made by means of pressure connectors (including set-screw type), solder lugs, or splices to flexible leads. Connection by means of wire-binding screws or studs and nuts that have upturned lugs or the equivalent shall be permitted for 10 AWG or smaller conductors.

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

(B) Splices. Conductors shall be spliced or joined with splicing devices identified for the use or by brazing, welding, or soldering with a fusible metal or alloy. Soldered splices shall first be spliced or joined so as to be mechanically and electrically secure without solder and then be 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 identified insulating device.

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

(C) Temperature Limitations. The temperature rating associated with the ampacity of a conductor shall be selected and coordinated so as not to exceed the lowest temperature rating of any connected termination, conductor, or device. Conductors with temperature ratings higher than specified for terminations shall be permitted to be used for ampacity adjustment, correction, or both.

(1) Equipment Provisions. The determination of termination provisions of equipment shall be based on 110.14(C)(1)(a) or (C)(1)(b). Unless the equipment is listed and marked otherwise, conductor ampacities used in determining equipment termination provisions shall be based on Table 310.16 as appropriately modified by 310.12.

(a) Termination provisions of equipment for circuits rated 100 amperes or less, or marked for 14 AWG through 1 AWG conductors, shall be used only for one of the following:

(1) Conductors rated 60°C (140°F).

- (2) Conductors with higher temperature ratings, provided the ampacity of such conductors is determined based on the 60°C (140°F) ampacity of the conductor size used.
- (3) Conductors with higher temperature ratings if the equipment is listed and identified for use with such conductors.
- (4) For motors marked with design letters B, C, or D, conductors having an insulation rating of 75°C (167°F) or higher shall be permitted to be used, provided the ampacity of such conductors does not exceed the 75°C (167°F) ampacity.

(b) Termination provisions of equipment for circuits rated over 100 amperes, or marked for conductors larger than 1 AWG, shall be used only for one of the following:

- (1) Conductors rated 75°C (167°F)
- (2) Conductors with higher temperature ratings, provided the ampacity of such conductors does not exceed the 75°C (167°F) ampacity of the conductor size used, or up to their ampacity if the equipment is listed and identified for use with such conductors

Δ (2) Separate Connector Provisions. Separately installed pressure connectors shall be used with conductors at the ampacities not exceeding the ampacity at the listed and identified temperature rating of the connector.

Informational Note: **Equipment** markings or listing information may additionally restrict the sizing and temperature ratings of connected conductors.

Δ (D) Terminal Connection Torque. Tightening torque values for terminal connections shall be as indicated on equipment or in installation instructions provided by the manufacturer. An approved means shall be used to achieve the indicated torque value.

Informational Note No. 1: Examples of approved means of achieving the indicated torque values include torque tools or devices such as shear bolts or breakaway-style devices with visual indicators that demonstrate that the proper torque has been applied.

Informational Note No. 2: See UL Standard 486A-486B, *Standard for Safety-Wire Connectors*, Informative Annex I for torque values in the absence of manufacturer's recommendations. The equipment manufacturer can be contacted if numeric torque values are not indicated on the equipment or if the installation instructions are not available.

Informational Note No. 3: See NFPA 70B-2019, *Recommended Practice for Electrical Equipment Maintenance*, Section 8.11 for additional information for torquing threaded connections and terminations.

110.15 High-Leg Marking. On a 4-wire, delta-connected system where the midpoint of one phase winding is grounded, only the conductor or busbar having the higher phase voltage to ground shall be durably and permanently marked by an outer finish that is orange in color or by other effective means. Such identification shall be placed at each point on the system where a connection is made if the grounded conductor is also present.

110.16 Arc-Flash Hazard Warning.

(A) General. Electrical equipment, such as switchboards, switchgear, **enclosed** panelboards, industrial control panels, meter socket enclosures, and motor control centers, that is in other than dwelling units, and is likely to require examination, adjustment, servicing, or maintenance while energized, shall be field or factory marked to warn qualified persons of potential

electric arc flash hazards. The marking shall meet the requirements in 110.21(B) and shall be located so as to be clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment.

- Δ (B) **Service Equipment and Feeder Supplied Equipment.** In other than dwelling units, in addition to the requirements in 110.16(A), a permanent arc flash label shall be field or factory applied to service equipment and feeder supplied equipment rated 1000 amperes or more. The arc flash label shall be in accordance with applicable industry practice and include the date the label was applied. The label shall meet the requirements of 110.21(B).

Informational Note No. 1: See ANSI Z535.4-2011 (R2017), *Product Safety Signs and Labels*, for guidelines for the design of safety signs and labels for application to products.

Informational Note No. 2: See NFPA 70E-2021, *Standard for Electrical Safety in the Workplace*, for applicable industry practices for equipment labeling. This standard provides specific criteria for developing arc-flash labels for equipment that provides nominal system voltage, incident energy levels, arc-flash boundaries, minimum required levels of personal protective equipment, and so forth.

- Δ 110.17 **Servicing and Maintenance of Equipment.** Servicing and electrical preventive maintenance shall be performed by qualified persons trained in servicing and maintenance of equipment and shall comply with the following:

- (1) The servicing and electrical preventive maintenance shall be performed in accordance with the original equipment manufacturer's instructions and information included in the listing information, applicable industry standards, or as approved by the authority having jurisdiction.
- (2) The servicing and electrical preventive maintenance shall be performed using identified replacement parts that are verified under applicable product standards. The replacement parts shall comply with at least one of the following:
 - a. Be provided by the original equipment manufacturer
 - b. Be designed by an engineer experienced in the design of replacement parts for the type of equipment being serviced or maintained
 - c. Be approved by the authority having jurisdiction

Informational Note No. 1: For equipment that is not listed or field labeled, or for which components are no longer available from the original equipment manufacturer, one way to determine suitability is to review the documentation that accompanies the replacement parts.

Informational Note No. 2: See NFPA 70B, *Recommended Practice for Electrical Equipment Maintenance*, for information related to preventive maintenance for electrical, electronic, and communication systems and equipment.

- Δ 110.18 **Arcing Parts.** Parts of electrical equipment that in ordinary operation produce arcs, sparks, flames, or molten metal shall be enclosed or separated and isolated from all combustible material.

110.19 **Light and Power from Railway Conductors.** Circuits for lighting and power shall not be connected to any system that contains trolley wires with a ground return.

Exception: Such circuit connections shall be permitted in car houses, power houses, or passenger and freight stations operated in connection with electric railways.

Δ 110.20 **Reconditioned Equipment.** Reconditioned equipment shall be permitted except where prohibited elsewhere in this *Code*. Equipment that is restored to operating condition shall be reconditioned with identified replacement parts, verified under applicable standards, that are either provided by the original equipment manufacturer or that are designed by an engineer experienced in the design of replacement parts for the type of equipment being reconditioned.

Δ (A) **Equipment Required to Be Listed.** Equipment that is reconditioned and required by this *Code* to be listed shall be listed or field labeled as reconditioned using available instructions from the original equipment manufacturer.

Δ (B) **Equipment Not Required to Be Listed.** Equipment that is reconditioned and not required by this *Code* to be listed shall comply with one of the following:

- (1) Be listed or field labeled as reconditioned
- (2) Have the reconditioning performed in accordance with the original equipment manufacturer instructions

Δ (C) **Approved Equipment.** If the options specified in 110.20(A) or (B) are not available, the authority having jurisdiction shall be permitted to approve reconditioned equipment, and the reconditioner shall provide the authority having jurisdiction with documentation of the changes to the product.

110.21 Marking.

(A) Equipment Markings.

Δ (1) **General.** The manufacturer's name, trademark, or other descriptive marking by which the organization responsible for the product can be identified shall be applied or affixed onto all electrical equipment. Other markings that indicate voltage, current, wattage, or other ratings shall be provided as specified elsewhere in this *Code*. The marking shall be of sufficient durability to withstand the environment involved.

Δ (2) **Reconditioned Equipment.** Reconditioned equipment shall be marked with the following:

- (1) Name, trademark, or other descriptive marking of the organization that performed the reconditioning
- (2) The date of the reconditioning
- (3) The term *reconditioned* or other approved wording or symbol indicating that the equipment has been reconditioned

The original listing mark shall be removed or made permanently illegible. The equipment nameplate shall not be required to be removed or made permanently illegible, only the part of the nameplate that includes the listing mark, if applicable. Approval of the reconditioned equipment shall not be based solely on the equipment's original listing.

Exception: In industrial occupancies, where conditions of maintenance and supervision ensure that only qualified persons service the equipment, the markings indicated in 110.21(A)(2) shall not be required for equipment that is reconditioned by the owner or operator as part of a regular equipment maintenance program.

Informational Note No. 1: ANSI-approved standards are available for application of reconditioned and refurbished equipment.

Informational Note No. 2: The term *reconditioned* may be interchangeable with the terms *rebuilt*, *refurbished*, or *remanufactured* even though these are sometimes different processes.

Δ (B) Field-Applied Hazard Markings. Where caution, warning, or danger hazard markings such as labels or signs are required by this *Code*, the markings shall meet the following requirements:

- (1) The marking shall be of sufficient durability to withstand the environment involved and warn of the hazards using effective words, colors, symbols, or any combination thereof.

Informational Note No. 1: See ANSI Z535.2-2011 (R2017), *Environmental and Facility Safety Signs*, which describes the design, application, and use of safety signs in facilities and in the environment.

Informational Note No. 2: See ANSI Z535.4-2011 (R2017), *Product Safety Signs and Labels*, which details the design, application, use, and placement of safety signs and labels on a wide variety of products.

- (2) The marking shall be permanently affixed to the equipment or wiring method and shall not be handwritten.

Exception to (2): Portions of the markings that are variable, or that could be subject to changes, shall be permitted to be handwritten and shall be legible.

110.22 Identification of Disconnecting Means.

(A) General. Each disconnecting means shall be legibly marked to indicate its purpose unless located and arranged so the purpose is evident. In other than one- or two-family dwellings, the marking shall include the identification and location of the circuit source that supplies the disconnecting means unless located and arranged so the identification and location of the circuit source is evident. The marking shall be of sufficient durability to withstand the environment involved.

(B) Engineered Series Combination Systems. Equipment enclosures for circuit breakers or fuses applied in compliance with series combination ratings selected under engineering supervision in accordance with 240.86(A) shall be legibly marked in the field as directed by the engineer to indicate the equipment has been applied with a series combination rating. The marking shall meet the requirements in 110.21(B) and shall be readily visible and state the following:

CAUTION — ENGINEERED SERIES COMBINATION
SYSTEM RATED _____ AMPERES. IDENTIFIED REPLACE-
MENT COMPONENTS REQUIRED.

(C) Tested Series Combination Systems. Equipment enclosures for circuit breakers or fuses applied in compliance with the series combination ratings marked on the equipment by the manufacturer in accordance with 240.86(B) shall be legibly marked in the field to indicate the equipment has been applied with a series combination rating. The marking shall meet the requirements in 110.21(B) and shall be readily visible and state the following:

CAUTION — SERIES COMBINATION SYSTEM RATED _____
AMPERES. IDENTIFIED REPLACEMENT COMPONENTS
REQUIRED.

Informational Note: See IEEE 3004.5-2014 *Recommended Practice for the Application of Low-Voltage Circuit Breakers in Industrial and Commercial Power Systems*, for further information on series tested systems.

110.23 Current Transformers. Unused current transformers associated with potentially energized circuits shall be short-circuited.

110.24 Available Fault Current.

Δ (A) Field Marking. Service equipment at other than dwelling units shall be legibly marked in the field with the available fault current. The field marking(s) shall include the date the fault-current calculation was performed and be of sufficient durability to withstand the environment involved. The calculation shall be documented and made available to those authorized to design, install, inspect, maintain, or operate the system.

Informational Note No. 1: See NFPA 70E-2021, *Standard for Electrical Safety in the Workplace*, for assistance in determining the severity of potential exposure, planning safe work practices, and selecting personal protective equipment. The available fault-current marking(s) addressed in 110.24 is related to required short-circuit current and interrupting ratings of equipment.

Informational Note No. 2: Values of available fault current for use in determining appropriate minimum short-circuit current and interrupting ratings of service equipment are available from electric utilities in published or other forms.

(B) Modifications. When modifications to the electrical installation occur that affect the available fault current at the service, the available fault current shall be verified or recalculated as necessary to ensure the service equipment ratings are sufficient for the available fault current at the line terminals of the equipment. The required field marking(s) in 110.24(A) shall be adjusted to reflect the new level of available fault current.

Exception: The field marking requirements in 110.24(A) and 110.24(B) shall not be required in industrial installations where conditions of maintenance and supervision ensure that only qualified persons service the equipment.

110.25 Lockable Disconnecting Means. If a disconnecting means is required to be lockable open elsewhere in this *Code*, it shall be capable of being locked in the open position. The provisions for locking shall remain in place with or without the lock installed.

Exception: Locking provisions for a cord-and-plug connection shall not be required to remain in place without the lock installed.

Part II. 1000 Volts, Nominal, or Less

110.26 Spaces About Electrical Equipment. Working space, and access to and egress from working space, shall be provided and maintained about all electrical equipment to permit ready and safe operation and maintenance of such equipment. Open equipment doors shall not impede access to and egress from the working space. Access or egress is impeded if one or more simultaneously opened equipment doors restrict working space access to be less than 610 mm (24 in.) wide and 2.0 m (6½ ft) high.

(A) Working Space. Working space for equipment operating at 1000 volts, nominal, or less to ground and likely to require examination, adjustment, servicing, or maintenance while energized shall comply with the dimensions of 110.26(A)(1), (A)(2), (A)(3), and (A)(4) or as required or permitted elsewhere in this *Code*.

Informational Note: See NFPA 70E-2021, *Standard for Electrical Safety in the Workplace*, for guidance, such as determining severity

of potential exposure, planning safe work practices including establishing an electrically safe work condition, arc flash labeling, and selecting personal protective equipment.

Δ (1) Depth of Working Space. The depth of the working space in the direction of live parts shall not be less than that specified in Table 110.26(A)(1) unless the requirements of 110.26(A)(1)(a), (A)(1)(b), or (A)(1)(c) are met. Distances shall be measured from the exposed live parts or from the enclosure or opening if the live parts are enclosed.

(a) **Dead-Front Assemblies.** Working space shall not be required in the back or sides of assemblies, such as dead-front switchboards, switchgear, or motor control centers, where all connections and all renewable or adjustable parts, such as fuses or switches, are accessible from locations other than the back or sides. Where rear access is required to work on nonelectrical parts on the back of enclosed equipment, a minimum horizontal working space of 762 mm (30 in.) shall be provided.

(b) **Low Voltage.** By special permission, smaller working spaces shall be permitted where all exposed live parts operate at not greater than 30 volts rms, 42 volts peak, or 60 volts dc.

(c) **Existing Buildings.** In existing buildings where electrical equipment is being replaced, Condition 2 working clearance shall be permitted between dead-front switchboards, switchgear, enclosed panelboards, or motor control centers located across the aisle from each other where conditions of maintenance and supervision ensure that written procedures have been adopted to prohibit equipment on both sides of the aisle from being open at the same time and qualified persons who are authorized will service the installation.

(2) Width of Working Space. The width of the working space in front of the electrical equipment shall be the width of the equipment or 762 mm (30 in.), whichever is greater. In all cases, the work space shall permit at least a 90-degree opening of equipment doors or hinged panels.

(3) Height of Working Space. The work space shall be clear and extend from the grade, floor, or platform to a height of 2.0 m (6½ ft) or the height of the equipment, whichever is greater. Within the height requirements of this section, other equipment or support structures, such as concrete pads, associated with the electrical installation and located above or below the electrical equipment shall be permitted to extend not more than 150 mm (6 in.) beyond the front of the electrical equipment.

Table 110.26(A)(1) Working Spaces

Nominal Voltage to Ground	Minimum Clear Distance		
	Condition 1	Condition 2	Condition 3
0–150	900 mm (3 ft)	900 mm (3 ft)	900 mm (3 ft)
151–600	900 mm (3 ft)	1.0 m (3 ft 6 in.)	1.2 m (4 ft)
601–1000	900 mm (3 ft)	1.2 m (4 ft)	1.5 m (5 ft)

Note: Where the conditions are as follows:

Condition 1 — Exposed live parts on one side of the working space and no live or grounded parts on the other side of the working space, or exposed live parts on both sides of the working space that are effectively guarded by insulating materials.

Condition 2 — Exposed live parts on one side of the working space and grounded parts on the other side of the working space. Concrete, brick, or tile walls shall be considered as grounded.

Condition 3 — Exposed live parts on both sides of the working space.

Exception No. 1: On battery systems mounted on open racks, the top clearance shall comply with 480.10(D).

Exception No. 2: In existing dwelling units, service equipment or enclosed panelboards that do not exceed 200 amperes shall be permitted in spaces where the height of the working space is less than 2.0 m (6½ ft).

Exception No. 3: Meters that are installed in meter sockets shall be permitted to extend beyond the other equipment. The meter socket shall be required to follow the rules of this section.

(4) Limited Access. Where equipment operating at 1000 volts, nominal, or less to ground and likely to require examination, adjustment, servicing, or maintenance while energized is required by installation instructions or function to be located in a space with limited access, all of the following shall apply:

- (1) Where equipment is installed above a lay-in ceiling, there shall be an opening not smaller than 559 mm × 559 mm (22 in. × 22 in.), or in a crawl space, there shall be an accessible opening not smaller than 559 mm × 762 mm (22 in. × 30 in.).
- (2) The width of the working space shall be the width of the equipment enclosure or a minimum of 762 mm (30 in.), whichever is greater.
- (3) All enclosure doors or hinged panels shall be capable of opening a minimum of 90 degrees.
- (4) The space in front of the enclosure shall comply with the depth requirements of Table 110.26(A)(1) and shall be unobstructed to the floor by fixed cabinets, walls, or partitions. Space reductions in accordance with 110.26(A)(1)(b) shall be permitted. The maximum height of the working space shall be the height necessary to install the equipment in the limited space. A horizontal ceiling structural member or access panel shall be permitted in this space provided the location of weight-bearing structural members does not result in a side reach of more than 150 mm (6 in.) to work within the enclosure.

(5) Separation from High-Voltage Equipment. Where switches, cutouts, or other equipment operating at 1000 volts, nominal, or less are installed in a vault, room, or enclosure where there are exposed live parts or exposed wiring operating over 1000 volts, nominal, the high-voltage equipment shall be effectively separated from the space occupied by the low-voltage equipment by a suitable partition, fence, or screen.

N (6) Grade, Floor, or Working Platform. The grade, floor, or platform in the required working space shall be kept clear, and the floor, grade, or platform in the working space shall be as level and flat as practical for the entire required depth and width of the working space.

(B) Clear Spaces. Working space required by this section 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) Entrance to and Egress from Working Space.

(1) Minimum Required. At least one entrance of sufficient area shall be provided to give access to and egress from working space about electrical equipment.

Δ (2) Large Equipment. For large equipment that contains over-current devices, switching devices, or control devices, there shall be one entrance to and egress from the required working space not less than 610 mm (24 in.) wide and 2.0 m (6½ ft)

high at each end of the working space. This requirement shall apply to either of the following conditions:

- (1) For equipment rated 1200 amperes or more and over 1.8 m (6 ft) wide
- (2) For service disconnecting means installed in accordance with 230.71(B) where the combined ampere rating is 1200 amperes or more and where the combined width is over 1.8 m (6 ft)

A single entrance to and egress from the required working space shall be permitted where either of the conditions in 110.26(C)(2)(a) or (C)(2)(b) is met.

(a) *Unobstructed Egress.* Where the location permits a continuous and unobstructed way of egress travel, a single entrance to the working space shall be permitted.

(b) *Extra Working Space.* Where the depth of the working space is twice that required by 110.26(A)(1), a single entrance shall be permitted. It shall be located such that the distance from the equipment to the nearest edge of the entrance is not less than the minimum clear distance specified in Table 110.26(A)(1) for equipment operating at that voltage and in that condition.

(3) **Personnel Doors.** Where equipment rated 800 amperes or more that contains overcurrent devices, switching devices, or control devices is installed and there is a personnel door(s) intended for entrance to and egress from the working space less than 7.6 m (25 ft) from the nearest edge of the working space, the door(s) shall open at least 90 degrees in the direction of egress and be equipped with listed panic hardware or listed fire exit hardware.

Informational Note: See UL 305, *Standard For Panic Hardware*, for additional information on panic hardware, and see UL 10C, *Standard for Safety for Positive Pressure Fire Tests of Door Assemblies*, for additional information.

(D) **Illumination.** Illumination shall be provided for all working spaces about service equipment, switchboards, switchgear, enclosed panelboards, or motor control centers installed indoors. Control by automatic means shall not be permitted to control all illumination within the working space. Additional lighting outlets shall not be required where the work space is illuminated by an adjacent light source or as permitted by 210.70(A)(1), Exception No. 1, for switched receptacles.

(E) **Dedicated Equipment Space.** All service equipment, switchboards, switchgear, panelboards, and motor control centers shall be located in dedicated spaces and protected from damage.

Exception: Control equipment that by its very nature or because of other rules of the Code must be adjacent to or within sight of its operating machinery shall be permitted in those locations.

(1) **Indoor.** Indoor installations shall comply with 110.26(E)(1)(a) through (E)(1)(d).

(a) *Dedicated Electrical Space.* The space equal to the width and depth of the equipment and extending from the floor to a height of 1.8 m (6 ft) above the equipment or to the structural ceiling, whichever is lower, shall be dedicated to the electrical installation. No piping, ducts, leak protection apparatus, or other equipment foreign to the electrical installation shall be located in this zone.

Exception: Suspended ceilings with removable panels shall be permitted within the 1.8 m (6 ft) zone.

(b) *Foreign Systems.* The area above the dedicated space required by 110.26(E)(1)(a) shall be permitted to contain foreign systems, provided protection is installed to avoid damage to the electrical equipment from condensation, leaks, or breaks in such foreign systems.

(c) *Sprinkler Protection.* Sprinkler protection shall be permitted for the dedicated space where the piping complies with this section.

(d) *Suspended Ceilings.* A dropped, suspended, or similar ceiling that does not add strength to the building structure shall not be considered a structural ceiling.

(2) **Outdoor.** Outdoor installations shall comply with 110.26(E)(2)(a) through (E)(2)(c).

(a) *Installation Requirements.* Outdoor electrical equipment shall be the following:

- (1) Installed in identified enclosures
- (2) Protected from accidental contact by unauthorized personnel or by vehicular traffic
- (3) Protected from accidental spillage or leakage from piping systems

(b) *Work Space.* The working clearance space shall include the zone described in 110.26(A). No architectural appurtenance or other equipment shall be located in this zone.

(c) *Dedicated Equipment Space.* The space equal to the width and depth of the equipment, and extending from grade to a height of 1.8 m (6 ft) above the equipment, shall be dedicated to the electrical installation. No piping or other equipment foreign to the electrical installation shall be located in this zone.

Exception: Structural overhangs or roof extensions shall be permitted in this zone.

(F) **Locked Electrical Equipment Rooms or Enclosures.** Electrical equipment rooms or enclosures housing electrical apparatus that are controlled by a lock(s) shall be considered accessible to qualified persons.

110.27 Guarding of Live Parts.

(A) **Live Parts Guarded Against Accidental Contact.** Except as elsewhere required or permitted by this Code, live parts of electrical equipment operating at 50 to 1000 volts, nominal shall be guarded against accidental contact by approved enclosures or by any of the following means:

- (1) By location in a room, vault, or similar enclosure that is accessible only to qualified persons.
- (2) By permanent, substantial partitions or screens arranged so that only qualified persons have access to the space within reach of the live parts. Any openings in such partitions or screens shall be sized and located so that persons are not likely to come into accidental contact with the live parts or to bring conducting objects into contact with them.
- (3) By location on a balcony, gallery, or platform elevated and arranged so as to exclude unqualified persons.
- (4) By elevation above the floor or other working surface as follows:
 - a. A minimum of 2.5 m (8 ft) for 50 volts to 300 volts between ungrounded conductors
 - b. A minimum of 2.6 m (8 ft 6 in.) for 301 volts to 600 volts between ungrounded conductors
 - c. A minimum of 2.62 m (8 ft 7 in.) for 601 volts to 1000 volts between ungrounded conductors

(B) Prevent Physical Damage. In locations where electrical equipment is likely to be exposed to physical damage, enclosures or guards shall be so arranged and of such strength as to prevent such damage.

Δ (C) Warning Signs. Entrances to rooms and other guarded locations that contain exposed live parts shall be marked with conspicuous warning signs forbidding unqualified persons to enter. The marking shall meet the requirements in 110.21(B).

110.28 Enclosure Types. Enclosures (other than surrounding fences or walls covered in 110.31) of switchboards, switchgear, enclosed panelboards, industrial control panels, motor control centers, meter sockets, enclosed switches, transfer switches, power outlets, circuit breakers, adjustable-speed drive systems,

pullout switches, portable power distribution equipment, termination boxes, general-purpose transformers, fire pump controllers, fire pump motors, and motor controllers, rated not over 1000 volts nominal and intended for such locations, shall be marked with an enclosure-type number as shown in Table 110.28.

Table 110.28 shall be used for selecting these enclosures for use in specific locations other than hazardous (classified) locations. The enclosures are not intended to protect against conditions such as condensation, icing, corrosion, or contamination that may occur within the enclosure or enter via the raceway or unsealed openings.

Δ Table 110.28 Enclosure Selection

Provides a Degree of Protection Against the Following Environmental Conditions	For Outdoor Use									
	Enclosure Type Number									
	3	3R	3S	3X	3RX	3SX	4	4X	6	6P
Incidental contact with the enclosed equipment	X	X	X	X	X	X	X	X	X	X
Rain, snow, and sleet	X	X	X	X	X	X	X	X	X	X
Sleet*	—	—	X	—	—	X	—	—	—	—
Windblown dust	X	—	X	X	—	X	X	X	X	X
Hosedown	—	—	—	—	—	—	X	X	X	X
Corrosive agents	—	—	—	X	X	X	—	X	—	X
Temporary submersion	—	—	—	—	—	—	—	—	X	X
Prolonged submersion	—	—	—	—	—	—	—	—	—	X

Provides a Degree of Protection Against the Following Environmental Conditions	For Indoor Use									
	Enclosure Type Number									
	1	2	4	4X	5	6	6P	12	12K	13
Incidental contact with the enclosed equipment	X	X	X	X	X	X	X	X	X	X
Falling dirt	X	X	X	X	X	X	X	X	X	X
Falling liquids and light splashing	—	X	X	X	X	X	X	X	X	X
Circulating dust, lint, fibers, and flyings	—	—	X	X	—	X	X	X	X	X
Settling airborne dust, lint, fibers, and flyings	—	—	X	X	X	X	X	X	X	X
Hosedown and splashing water	—	—	X	X	—	X	X	—	—	—
Oil and coolant seepage	—	—	—	—	—	—	—	X	X	X
Oil or coolant spraying and splashing	—	—	—	—	—	—	—	—	—	X
Corrosive agents	—	—	—	X	—	—	X	—	—	—
Temporary submersion	—	—	—	—	—	X	X	—	—	—
Prolonged submersion	—	—	—	—	—	—	X	—	—	—

*The mechanism shall be operable when ice covered.

Informational Note No. 1: The term *raintight* is typically used in conjunction with Enclosure Types 3, 3S, 3SX, 3X, 4, 4X, 6, and 6P. The term *rainproof* is typically used in conjunction with Enclosure Types 3R and 3RX. The term *watertight* is typically used in conjunction with Enclosure Types 4, 4X, 6, and 6P. The term *driptight* is typically used in conjunction with Enclosure Types 2, 5, 12, 12K, and 13. The term *dusttight* is typically used in conjunction with Enclosure Types 3, 3S, 3SX, 3X, 4, 4X, 5, 6, 6P, 12, 12K, and 13.

Informational Note No. 2: See ANSI/IEC 60529, *Degrees of Protection Provided by Enclosures*, for ingress protection (IP) ratings.

Informational Note No. 3: See 502.10(A)(3), 502.10(B)(4), 503.10(A)(2), and 506.15(C)(9) for information on the use of dusttight enclosures in hazardous locations.

Informational Note No. 4: Some enclosure types, such as 12, 12K, or 13 enclosures, may be marked with an ancillary “-XH” for corrosive and hosedown capable indoor enclosure.

Informational Note No. 5: Some type 4X enclosures may be marked “indoor only.”

Informational Note No. 6: See UL 508A, *Standard for Industrial Control Panels*, for information on determining applicable requirements for evaluating type 4, 4X, and 12 ventilated enclosures.

Informational Note No. 7: See NEMA 250, *Enclosures for Electrical Equipment (1000 Volts Maximum)*, for the description of the “Enclosure Type Rating: Ancillary — PW for Pressure Wash.”

N 110.29 In Sight From (Within Sight From, Within Sight).

Where this *Code* specifies that one equipment shall be “in sight from,” “within sight from,” or “within sight of” another equipment, the specified equipment shall be visible and not more than 15 m (50 ft) distant from the other.

Part III. Over 1000 Volts, Nominal

110.30 General. Conductors and equipment used on circuits over 1000 volts, nominal, shall comply with Part I of this article and with 110.30 through 110.41, which supplement or modify Part I. In no case shall this part apply to equipment on the supply side of the service point.

Δ 110.31 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 a lock(s) or other approved means, shall be considered to be accessible to qualified persons only. The type of enclosure used in a given case shall be designed and constructed according to the nature and degree of the hazard(s) associated with the installation.

For installations other than equipment as described in 110.31(D), a wall, screen, or fence shall be used to enclose an outdoor electrical installation to deter access by persons who are not qualified. A fence shall not be less than 2.1 m (7 ft) in height or a combination of 1.8 m (6 ft) or more of fence fabric and a 300 mm (1 ft) or more extension utilizing three or more strands of barbed wire or equivalent. The distance from the fence to live parts shall be not less than given in Table 110.31.

Informational Note: See ANSI/IEEE C2-2017, *National Electrical Safety Code*, for clearances of conductors for specific system voltages and typical BIL ratings.

(A) Electrical Vaults. Where an electrical vault is required or specified for conductors and equipment 110.31(A)(1) to (A)(5) shall apply.

(1) Walls and Roof. The walls and roof shall be constructed of materials that have adequate structural strength for the conditions, with a minimum fire rating of 3 hours. For the purpose of this section, studs and wallboard construction shall not be permitted.

(2) Floors. The floors of vaults in contact with the earth shall be of concrete that is not less than 102 mm (4 in.) thick, but where the vault is constructed with a vacant space or other stories below it, the floor shall have adequate structural strength for the load imposed on it and a minimum fire resistance of 3 hours.

(3) Doors. Each doorway leading into a vault from the building interior shall be provided with a tight-fitting door that has a minimum fire rating of 3 hours. The authority having jurisdiction shall be permitted to require such a door for an exterior wall opening where conditions warrant.

Exception to (1), (2), and (3): Where the vault is protected with automatic sprinkler, water spray, carbon dioxide, or halon, construction with a 1-hour rating shall be permitted.

(4) Locks. Doors shall be equipped with locks, and doors shall be kept locked, with access allowed only to qualified persons. Personnel doors shall open at least 90 degrees in the direction of egress and be equipped with listed panic hardware or listed fire exit hardware.

Informational Note: See UL 305, *Standard for Panic Hardware*, for additional information, and UL10C, *Standard for Safety for Positive Pressure Fire Tests of Door Assemblies*.

(5) Transformers. Where a transformer is installed in a vault as required by Part II of Article 450, the vault shall be constructed in accordance with Part III of Article 450.

Informational Note No. 1: See ANSI/ASTM E119-2018a, *Method for Fire Tests of Building Construction and Materials*, for additional information, and see NFPA 80-2019, *Standard for Fire Doors and Other Opening Protectives*.

Informational Note No. 2: A typical 3-hour construction is 150 mm (6 in.) thick reinforced concrete.

(B) Indoor Installations.

(1) In Places Accessible to Unqualified Persons. Indoor electrical installations that are accessible to unqualified persons shall be made with metal-enclosed equipment. Switchgear, transformers, pull boxes, connection boxes, and other similar associated equipment shall be marked with appropriate caution signs. Openings in ventilated dry-type transformers or similar openings in other equipment shall be designed so that foreign objects inserted through these openings are deflected from energized parts.

(2) In Places Accessible to Qualified Persons Only. Indoor electrical installations considered accessible only to qualified persons in accordance with this section shall comply with 110.34, 110.36, and 495.24.

(C) Outdoor Installations.

(1) In Places Accessible to Unqualified Persons. Outdoor electrical installations that are open to unqualified persons shall comply with Part III of Article 225.

(2) In Places Accessible to Qualified Persons Only. Outdoor electrical installations that have exposed live parts shall be accessible to qualified persons only in accordance with the first paragraph of this section and shall comply with 110.34, 110.36, and 495.24.

(D) Enclosed Equipment Accessible to Unqualified Persons. Ventilating or similar openings in equipment shall be designed such that foreign objects inserted through these openings are deflected from energized parts. Where exposed to physical damage from vehicular traffic, suitable guards shall be provided. Equipment located outdoors and accessible to unqualified persons shall be designed such that exposed nuts or bolts cannot be readily removed, permitting access to live parts. Where equipment is accessible to unqualified persons and the bottom of the enclosure is less than 2.5 m (8 ft) above the floor or grade level, the enclosure door or hinged cover shall be kept locked. Doors and covers of enclosures used solely as pull boxes, splice boxes, or junction boxes shall be locked, bolted, or screwed on. Underground box covers that weigh over

Δ Table 110.31 Minimum Distance from Fence to Live Parts

Nominal Voltage	Minimum Distance to Live Parts	
	m	ft
1001–13,799	3.05	10
13,800–230,000	4.57	15
Over 230,000	5.49	18

45.4 kg (100 lb) shall be considered as meeting this requirement.

110.32 Work Space About Equipment. Sufficient space shall be provided and maintained about electrical equipment to permit ready and safe operation and maintenance of such equipment. Where energized parts are exposed, the minimum clear work space shall be not less than 2.0 m (6½ ft) high (measured vertically from the floor or platform) and the width of the equipment or 914 mm (3 ft) wide (measured parallel to the equipment), whichever is greater. The depth shall be as required in 110.34(A). In all cases, the work space shall permit at least a 90-degree opening of doors or hinged panels. Within the height requirements of this section, other equipment that is associated with the electrical installation and is located above or below the electrical equipment shall be permitted to extend not more than 150 mm (6 in.) beyond the front of the electrical equipment. Working space required by this section 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.

110.33 Entrance to Enclosures and Access to Working Space.

(A) Entrance. At least one entrance to enclosures for electrical installations as described in 110.31 not less than 610 mm (24 in.) wide and 2.0 m (6½ ft) high shall be provided to give access to the working space about electrical equipment.

Open equipment doors shall not impede access to and egress from the working space. Access or egress is impeded if one or more simultaneously opened equipment doors restrict working space access to be less than 610 mm (24 in.) wide and 2.0 m (6½ ft) high.

(1) Large Equipment. On switchgear and control panels exceeding 1.8 m (6 ft) in width, there shall be one entrance at each end of the equipment. A single entrance to the required working space shall be permitted where either of the conditions in 110.33(A)(1)(a) or (A)(1)(b) is met.

(a) *Unobstructed Exit.* Where the location permits a continuous and unobstructed way of exit travel, a single entrance to the working space shall be permitted.

(b) *Extra Working Space.* Where the depth of the working space is twice that required by 110.34(A), a single entrance shall be permitted. It shall be located so that the distance from the equipment to the nearest edge of the entrance is not less than the minimum clear distance specified in Table 110.34(A) for equipment operating at that voltage and in that condition.

(2) Guarding. Where bare energized parts at any voltage or insulated energized parts above 1000 volts, nominal, are located adjacent to such entrance, they shall be suitably guarded.

(3) Personnel Doors. Where there are personnel doors intended for entrance to and egress from the working space less than 7.6 m (25 ft) from the nearest edge of the working space, the doors shall open at least 90 degrees in the direction of egress and be equipped with listed panic hardware or listed fire exit hardware.

Informational Note: See UL 305, *Standard for Panic Hardware*, for additional information, and UL 10C, *Standard for Safety for Positive Pressure Fire Tests of Door Assemblies*.

(B) Access. Permanent ladders or stairways shall be provided to give safe access to the working space around electrical equip-

ment installed on platforms, balconies, or mezzanine floors or in attic or roof rooms or spaces.

110.34 Work Space and Guarding.

(A) Working Space. Except as elsewhere required or permitted in this *Code*, equipment likely to require examination, adjustment, servicing, or maintenance while energized shall have clear working space in the direction of access to live parts of the electrical equipment and shall be not less than specified in Table 110.34(A). Distances shall be measured from the live parts, if such are exposed, or from the enclosure front or opening if such are enclosed. The grade, floor, or platform in the required working space shall be kept clear, and the floor, grade, or platform in the working space shall be as level and flat as practical for the entire depth and width of the working space.

Exception: Working space shall not be required in back of equipment such as switchgear 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 nonelectrical parts on the back of enclosed equipment, a minimum working space of 762 mm (30 in.) horizontally shall be provided.

(B) Separation from Low-Voltage Equipment. Where switches, cutouts, or other equipment operating at 1000 volts, nominal, or less are installed in a vault, room, or enclosure where there are exposed live parts or exposed wiring operating at over 1000 volts, nominal, the high-voltage equipment shall be effectively separated from the space occupied by the low-voltage equipment by a suitable partition, fence, or screen.

Exception: Switches or other equipment operating at 1000 volts, nominal, or less and serving only equipment within the high-voltage vault, room, or enclosure shall be permitted to be installed in the high-voltage vault, room, or enclosure without a partition, fence, or screen if accessible to qualified persons only.

(C) Locked Rooms or Enclosures. The entrance to all buildings, vaults, rooms, or enclosures containing exposed live parts or exposed conductors operating at over 1000 volts, nominal, shall be kept locked unless such entrances are under the observation of a qualified person at all times.

▲ **Table 110.34(A) Minimum Depth of Clear Working Space at Electrical Equipment**

Nominal Voltage to Ground	Minimum Clear Distance		
	Condition 1	Condition 2	Condition 3
1001–2500 V	900 mm (3 ft)	1.2 m (4 ft)	1.5 m (5 ft)
2501–9000 V	1.2 m (4 ft)	1.5 m (5 ft)	1.8 m (6 ft)
9001–25,000 V	1.5 m (5 ft)	1.8 m (6 ft)	2.8 m (9 ft)
25,001 V–75 kV	1.8 m (6 ft)	2.5 m (8 ft)	3.0 m (10 ft)
Above 75 kV	2.5 m (8 ft)	3.0 m (10 ft)	3.7 m (12 ft)

Note: Where the conditions are as follows:

Condition 1 — Exposed live parts on one side of the working space and no live or grounded parts on the other side of the working space, or exposed live parts on both sides of the working space that are effectively guarded by insulating materials.

Condition 2 — Exposed live parts on one side of the working space and grounded parts on the other side of the working space. Concrete, brick, or tile walls shall be considered as grounded.

Condition 3 — Exposed live parts on both sides of the working space.

Permanent and conspicuous danger signs shall be provided. The danger sign shall meet the requirements in 110.21(B) and shall read as follows:

DANGER — HIGH VOLTAGE — KEEP OUT

(D) Illumination. Illumination shall be provided for all working spaces about electrical equipment. Control by automatic means only shall not be permitted. The lighting outlets shall be arranged so that persons changing lamps or making repairs on the lighting system are not endangered by live parts or other equipment.

The points of control shall be located so that persons are not likely to come in contact with any live part or moving part of the equipment while turning on the lights.

(E) Elevation of Unguarded Live Parts. Unguarded live parts above working space shall be maintained at elevations not less than required by Table 110.34(E).

(F) Protection of Service Equipment, Switchgear, and Industrial Control Assemblies. Pipes or ducts foreign to the electrical installation and requiring periodic maintenance or whose malfunction would endanger the operation of the electrical system shall not be located in the vicinity of the service equipment, switchgear, or industrial control assemblies. Protection shall be provided where necessary to avoid damage from condensation leaks and breaks in such foreign systems. Piping and other facilities shall not be considered foreign if provided for fire protection of the electrical installation.

110.36 Circuit Conductors. Circuit conductors shall be permitted to be installed in raceways; in cable trays; as metal-clad cable Type MC; as bare wire, cable, and busbars; or as Type MV cables or conductors as provided in 305.3, 305.9, 305.10, and 305.15. Bare live conductors shall comply with 495.24.

Insulators, together with their mounting and conductor attachments, where used as supports for wires, single-conductor cables, or busbars, shall be capable of safely withstanding the maximum magnetic forces that would prevail if two or more conductors of a circuit were subjected to short-circuit current.

Exposed runs of insulated wires and cables that have 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. Supports for lead-covered cables shall be designed to prevent electrolysis of the sheath.

110.40 Temperature Limitations at Terminations. Conductors shall be permitted to be terminated based on the 90°C (194°F) temperature rating and ampacity as given in Table 315.60(C) (1) through Table 315.60(C) (20), unless otherwise identified.

Table 110.34(E) Elevation of Unguarded Live Parts Above Working Space

Nominal Voltage Between Phases	Elevation	
	m	ft
1001–7500 V	2.7	9
7501–35,000 V	2.9	9 ft 6 in.
Over 35 kV	Add 9.5 mm per kV above 35 kV	Add 0.37 in. per kV above 35 kV

110.41 Inspections and Tests.

(A) Pre-energization and Operating Tests. Where required elsewhere in this *Code*, the complete electrical system design, including settings for protective, switching, and control circuits, shall be prepared in advance and made available on request to the authority having jurisdiction and shall be tested when first installed on-site.

(B) Test Report. A test report covering the results of the tests required in 110.41(A) shall be available to the authority having jurisdiction prior to energization and made available to those authorized to install, operate, test, and maintain the system.

Part IV. Tunnel Installations over 1000 Volts, Nominal

110.51 General.

(A) Covered. This part shall apply to the installation and use of high-voltage power distribution and utilization equipment that is portable, mobile, or both, such as substations, trailers, cars, mobile shovels, draglines, hoists, drills, dredges, compressors, pumps, conveyors, underground excavators, and the like.

(B) Protection Against Physical Damage. Conductors and cables in tunnels shall be located above the tunnel floor and so placed or guarded to protect them from physical damage.

110.52 Overcurrent Protection. Motor-operated equipment shall be protected from overcurrent in accordance with Parts III, IV, and V of Article 430. Transformers shall be protected from overcurrent in accordance with 450.3.

Δ 110.53 Conductors. High-voltage conductors in tunnels shall be installed in metal raceway, Type MC cable, or other approved multiconductor cable. Multiconductor portable cable shall be permitted to supply mobile equipment.

110.54 Bonding and Equipment Grounding Conductors.

(A) Grounded and Bonded. All non-current-carrying metal parts of electrical equipment and all metal raceways and cable sheaths shall be solidly grounded and bonded to all metal pipes and rails at the portal and at intervals not exceeding 300 m (1000 ft) throughout the tunnel.

(B) Equipment Grounding Conductors. 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.

110.55 Transformers, Switches, and Electrical Equipment. All transformers, switches, motor controllers, motors, rectifiers, and other equipment installed belowground shall be protected from physical damage by location or guarding.

110.56 Energized Parts. Bare terminals of transformers, switches, motor controllers, and other equipment shall be enclosed to prevent accidental contact with energized parts.

110.57 Ventilation System Controls. Electrical controls for the ventilation system shall be arranged so that the airflow can be reversed.

110.58 Disconnecting Means. A switch or circuit breaker that simultaneously opens all ungrounded conductors of the circuit shall be installed within sight of each transformer or motor location for disconnecting the transformer or motor. The

switch or circuit breaker for a transformer shall have an ampere rating not less than the ampacity of the transformer supply conductors. The switch or circuit breaker for a motor shall comply with the applicable requirements of **Part IX** of Article 430.

110.59 Enclosures. Enclosures for use in tunnels shall be drip-proof, weatherproof, or submersible as required by the environmental conditions. Switch or contactor enclosures shall not be used as junction boxes or as raceways for conductors feeding through or tapping off to other switches, unless the enclosures comply with 312.8.

Part V. Manholes and Other Electrical Enclosures Intended for Personnel Entry

110.70 General. Electrical enclosures intended for personnel entry and specifically fabricated for this purpose shall be of sufficient size to provide safe work space about electrical equipment with live parts that is likely to require examination, adjustment, servicing, or maintenance while energized. Such enclosures shall have sufficient size to permit ready installation or withdrawal of the conductors employed without damage to the conductors or to their insulation. They shall comply with this part.

Exception: Where electrical enclosures covered by Part V of this article are part of an industrial wiring system operating under conditions of maintenance and supervision that ensure that only qualified persons monitor and supervise the system, they shall be permitted to be designed and installed in accordance with appropriate engineering practice. If required by the authority having jurisdiction, design documentation shall be provided.

110.71 Strength. Manholes, vaults, and their means of access shall be designed under qualified engineering supervision and shall withstand all loads likely to be imposed on the structures.

Informational Note: See ANSI C2-2007, *National Electrical Safety Code*, for additional information on the loading that can be expected to bear on underground enclosures.

110.72 Cabling Work Space. A clear work space not less than 900 mm (3 ft) wide shall be provided where cables are located on both sides, and not less than 750 mm (2½ ft) where cables are only on one side. The vertical headroom shall be not less than 1.8 m (6 ft) unless the opening is within 300 mm (1 ft), measured horizontally, of the adjacent interior side wall of the enclosure.

Exception: A manhole containing only one or more of the following shall be permitted to have one of the horizontal work space dimensions reduced to 600 mm (2 ft) where the other horizontal clear work space is increased so the sum of the two dimensions is not less than 1.8 m (6 ft):

- (1) *Optical fiber cables*
- (2) *Power-limited fire alarm circuits supplied in accordance with 760.121*
- (3) *Class 2 or Class 3 remote-control and signaling circuits, or both, supplied in accordance with 725.60*

110.73 Equipment Work Space. Where electrical equipment with live parts that is likely to require examination, adjustment, servicing, or maintenance while energized is installed in a manhole, vault, or other enclosure designed for personnel access, the work space and associated requirements in 110.26 shall be met for installations operating at 1000 volts or less. Where the installation is over 1000 volts, the work space and

associated requirements in 110.34 shall be met. A manhole access cover that weighs over 45.4 kg (100 lb) shall be considered as meeting the requirements of 110.26(F) and 110.34(C).

110.74 Conductor Installation. Conductors installed in manholes and other enclosures intended for personnel entry shall be cabled, racked up, or arranged in an approved manner that provides ready and safe access for persons to enter for installation and maintenance. The installation shall comply with 110.74(A) or 110.74(B), as applicable.

Δ (A) 1000 Volts, Nominal, or Less. Wire bending space for conductors operating at 1000 volts or less shall be provided in accordance with 314.28.

(B) Over 1000 Volts, Nominal. Conductors operating at over 1000 volts shall be provided with bending space in accordance with 314.71(A) and (B), as applicable.

Exception: Where 314.71(B) applies, each row or column of ducts on one wall of the enclosure shall be calculated individually, and the single row or column that provides the maximum distance shall be used.

110.75 Access to Manholes.

Δ (A) Dimensions. Rectangular access openings shall not be less than 650 mm × 550 mm (26 in. × 22 in.). Round access openings in a manhole shall be not less than 650 mm (26 in.) in diameter.

Exception: A manhole that has a fixed ladder that does not obstruct the opening or that contains only one or more of the following shall be permitted to reduce the minimum cover diameter to 600 mm (2 ft):

- (1) *Optical fiber cables*
- (2) *Power-limited fire alarm circuits supplied in accordance with 760.121*
- (3) *Class 2 or Class 3 remote-control and signaling circuits, or both, supplied in accordance with 725.60*

(B) Obstructions. Manhole openings shall be free of protrusions that could injure personnel or prevent ready egress.

(C) Location. Manhole openings for personnel shall be located where they are not directly above electrical equipment or conductors in the enclosure. Where this is not practicable, either a protective barrier or a fixed ladder shall be provided.

(D) Covers. Covers shall be over 45 kg (100 lb) or otherwise designed to require the use of tools to open. They shall be designed or restrained so they cannot fall into the manhole or protrude sufficiently to contact electrical conductors or equipment within the manhole.

(E) Marking. Manhole covers shall have an identifying mark or logo that prominently indicates their function, such as “electric.”

110.76 Access to Vaults and Tunnels.

(A) Location. Access openings for personnel shall be located where they are not directly above electrical equipment or conductors in the enclosure. Other openings shall be permitted over equipment to facilitate installation, maintenance, or replacement of equipment.

(B) Locks. In addition to compliance with the requirements of 110.34, if applicable, access openings for personnel shall be arranged such that a person on the inside can exit when the access door is locked from the outside, or in the case of

normally locking by padlock, the locking arrangement shall be such that the padlock can be closed on the locking system to prevent locking from the outside.

110.77 Ventilation. Where manholes, tunnels, and vaults have communicating openings into enclosed areas used by the public, ventilation to open air shall be provided wherever practicable.

110.78 Guarding. Where conductors or equipment, or both, could be contacted by objects falling or being pushed through a ventilating grating, both conductors and live parts shall be protected in accordance with the requirements of 110.27(A)(2) or 110.31(B)(1), depending on the voltage.

110.79 Fixed Ladders. Fixed ladders shall be corrosion resistant.

Chapter 2 Wiring and Protection

ARTICLE 200

Use and Identification of Grounded Conductors

200.1 Scope. This article provides requirements for the following:

- (1) Identification of terminals
- (2) Grounded conductors in premises wiring systems
- (3) Identification of grounded conductors

Informational Note: See Article 100 for definitions of *Grounded Conductor*, *Equipment Grounding Conductor*, and *Grounding Electrode Conductor*.

200.2 General. Grounded conductors shall comply with 200.2(A) and (B).

(A) Insulation. The grounded conductor, if insulated, shall have insulation that complies with either one of the following:

- (1) Is suitably rated, other than color, for any ungrounded conductor of the same circuit for systems of 1000 volts or less.
- (2) Is rated not less than 600 volts for solidly grounded neutral systems of over 1000 volts in accordance with 250.184(A)

(B) Continuity. The continuity of a grounded conductor shall not depend on a connection to a metal enclosure, raceway, or cable armor.

Informational Note: See 300.13(B) for the continuity of grounded conductors used in multiwire branch circuits.

200.3 Connection to Grounded System. Grounded conductors of premises wiring systems shall be electrically connected to the supply system grounded conductor to ensure a common, continuous grounded system. For the purpose of this section, *electrically connected* shall mean making a direct electrical connection capable of carrying current, as distinguished from induced currents.

Exception: Listed interactive inverters identified for use in distributed resource generation systems such as photovoltaic and fuel cell power systems shall be permitted to be connected to premises wiring without a grounded conductor if the connected premises wiring or utility system includes a grounded conductor.

200.4 Neutral Conductors. Neutral conductors shall be installed in accordance with 200.4(A) and (B).

(A) Installation. Neutral conductors shall not be used for more than one branch circuit, for more than one multiwire branch circuit, or for more than one set of ungrounded feeder conductors unless specifically permitted elsewhere in this Code.

Informational Note: See 215.4 for information on common neutrals.

(B) Multiple Circuits. Where more than one neutral conductor associated with different circuits is in an enclosure, grounded circuit conductors of each circuit shall be identified or grouped to correspond with the ungrounded circuit conduc-

tor(s) by wire markers, cable ties, or similar means in at least one location within the enclosure.

Exception No. 1: The requirement for grouping or identifying shall not apply if the branch-circuit or feeder conductors enter from a cable or a raceway unique to the circuit that makes the grouping obvious.

Exception No. 2: The requirement for grouping or identifying shall not apply where branch-circuit conductors pass through a box or conduit body without a loop as described in 314.16(B)(1) or without a splice or termination.

200.6 Means of Identifying Grounded Conductors.

Δ (A) Sizes 6 AWG or Smaller. The insulation of grounded conductors of 6 AWG or smaller shall be identified by one of the following means:

- (1) A continuous white outer finish.
- (2) A continuous gray outer finish.
- (3) Three continuous white or gray stripes along the conductor's entire length on other than green insulation.
- (4) Conductors with white or gray insulation and colored tracer threads in the braid identifying the source of manufacture.
- (5) A single-conductor, sunlight-resistant, outdoor-rated cable used as a solidly grounded conductor in photovoltaic power systems, as permitted by 690.31(C)(1), shall be identified at the time of installation by markings at terminations in accordance with 200.6(A)(1) through (A)(4).
- (6) The grounded conductor of a mineral-insulated, metal-sheathed cable (Type MI) shall be identified at the time of installation by a distinctive white or gray marking at its terminations. The marking shall encircle the conductor insulation.
- (7) Fixture wire shall comply with the requirements for grounded conductor identification in accordance with 402.8.
- (8) For aerial cable, the identification shall comply with one of the methods in 200.6(A)(1) through (A)(5), or by means of a ridge located on the exterior of the cable so as to identify it.

Δ (B) Sizes 4 AWG or Larger. An insulated grounded conductor 4 AWG or larger shall be identified by one of the following means:

- (1) A continuous white outer finish.
- (2) A continuous gray outer finish.
- (3) Three continuous white or gray stripes along the entire length on other than green insulation.
- (4) At the time of installation, be identified by a distinctive white or gray marking at its terminations. This marking shall encircle the conductor insulation.

(C) Flexible Cords. An insulated conductor that is intended for use as a grounded conductor, where contained within a flexible cord, shall be identified by a white or gray outer finish or by methods permitted by 400.22.

Δ (D) Grounded Conductors of Different Nominal Voltage Systems. If grounded conductors of different nominal voltage systems are installed in the same raceway, cable, box, auxiliary gutter, or other type of enclosure, each grounded conductor

shall be identified by nominal voltage system. Identification that distinguishes each nominal voltage system grounded conductor shall be permitted by one of the following means:

- (1) One nominal voltage system grounded conductor shall have an outer covering conforming to 200.6(A) or (B).
- (2) The grounded conductor(s) of other nominal voltage systems shall have a different outer covering conforming to 200.6(A) or (B) or by an outer covering of white or gray with a distinguishable colored stripe other than green running along the insulation.
- (3) Other and different means of identification allowed by 200.6(A) or (B) shall distinguish each nominal voltage system grounded conductor.

The means of identification shall be documented in a manner that is readily available or shall be permanently posted where the conductors of different nominal voltage systems originate.

(E) Grounded Conductors of Multiconductor Cables. The insulated grounded conductor(s) in a multiconductor cable shall be identified by a continuous white or gray outer finish or by three continuous white or gray stripes on other than green insulation along its entire length. For conductors that are 4 AWG or larger in cables, identification of the grounded conductor shall be permitted to comply with 200.6(B). For multiconductor flat cable with conductors that are 4 AWG or larger, an external ridge shall be permitted to identify the grounded conductor.

Exception No. 1: Conductors within multiconductor cables shall be permitted to be re-identified at their terminations at the time of installation by a distinctive white or gray marking or other equally effective means.

Exception No. 2: The grounded conductor of a multiconductor varnished-cloth-insulated cable shall be permitted to be identified at its terminations at the time of installation by a distinctive white marking or other equally effective means.

Informational Note: The color gray may have been used in the past as an ungrounded conductor. Care should be taken when working on existing systems.

200.7 Use of Insulation of a White or Gray Color or with Three Continuous White or Gray Stripes.

(A) General. The following shall be used only for the grounded circuit conductor, unless otherwise permitted in 200.7(B) and (C):

- (1) A conductor with continuous white or gray covering
- (2) A conductor with three continuous white or gray stripes on other than green insulation
- (3) A marking of white or gray color at the termination

(B) Circuits of Less Than 50 Volts. A conductor with white or gray color insulation or three continuous white stripes or having a marking of white or gray at the termination for circuits of less than 50 volts shall be required to be grounded only in accordance with 250.20(A).

(C) Circuits of 50 Volts or More. The use of insulation that is white or gray or that has three continuous white or gray stripes for other than a grounded conductor for circuits of 50 volts or more shall be permitted only as in the following:

- (1) If part of a cable assembly that has the insulation permanently reidentified to indicate its use as an ungrounded

conductor by marking tape, painting, or other effective means at its termination and at each location where the conductor is visible and accessible. Identification shall encircle the insulation and shall be a color other than white, gray, or green. If used for single-pole, 3-way or 4-way switch loops, the reidentified conductor with white or gray insulation or three continuous white or gray stripes shall be used only for the supply to the switch, but not as a return conductor from the switch to the outlet.

- (2) A flexible cord having one conductor identified by a white or gray outer finish or three continuous white or gray stripes, or by any other means in accordance with 400.22, that is used for connecting an appliance or equipment in accordance with 400.10. This shall apply to flexible cords connected to outlets whether or not the outlet is supplied by a circuit that has a grounded conductor.

Informational Note: The color gray may have been used in the past as an ungrounded conductor. Care should be taken when working on existing systems.

Δ 200.9 Means of Identification of Terminals. In devices or utilization equipment with polarized connections, identification of terminals to which a grounded conductor is to be connected shall be white or silver in color. The identification of other terminals shall be of a distinguishable different color.

Exception: If the conditions of maintenance and supervision ensure that only qualified persons service the installations, terminals for grounded conductors shall be permitted to be permanently identified at the time of installation by a distinctive white marking or other equally effective means.

200.10 Identification of Terminals.

Δ (A) Device Terminals. All devices, excluding panelboards, provided with terminals for the attachment of conductors and intended for connection to more than one side of the circuit shall have terminals marked for identification, unless the electrical connection of the terminal intended to be connected to the grounded conductor is clearly evident.

Exception: Terminal identification shall not be required for devices that have a current rating of over 30 amperes, other than polarized attachment plugs and polarized receptacles for attachment plugs in accordance with 200.10(B).

Δ (B) Receptacles, Plugs, and Connectors. Receptacles, polarized attachment plugs, and cord connectors for plugs and polarized plugs shall have the terminal intended for connection to the grounded conductor identified as follows:

- (1) Identification shall be by a metal or metal coating that is white or silver in color or by the word "white" or the letter "W" located adjacent to the identified terminal.
- (2) If the terminal is not visible, the conductor entrance hole for the connection shall be colored white or marked with the word "white" or the letter "W."

Informational Note: See 250.126 for identification of wiring device equipment grounding conductor terminals.

(C) Screw Shells. For devices with screw shells, the terminal for the grounded conductor shall be the one connected to the screw shell.

(D) Screw Shell Devices with Leads. For screw shell devices with attached leads, the conductor attached to the screw shell shall have a white or gray finish. The outer finish of the other conductor shall be of a solid color that will not be confused

with the white or gray finish used to identify the grounded conductor.

Informational Note: The color gray may have been used in the past as an ungrounded conductor. **Caution** should be taken when working on existing systems.

(E) Appliances. Appliances that have a single-pole switch or a single-pole overcurrent device in the line or any line-connected screw shell lampholders, and that are to be connected by (1) a permanent wiring method or (2) field-installed attachment plugs and cords with three or more wires (including the equipment grounding conductor), shall have means to identify the terminal for the grounded circuit conductor (if any).

200.11 Polarity of Connections. No grounded conductor shall be attached to any terminal or lead so as to reverse the designated polarity.

ARTICLE 210

Branch Circuits Not Over 1000 Volts ac, 1500 Volts dc, Nominal

Δ Part I. General

210.1 Scope. This article provides the general requirements for branch circuits not over 1000 volts ac, 1500 volts dc, nominal.

Informational Note: See Part II of Article 235 for requirements for branch circuits over 1000 volts ac, 1500 volts dc, nominal.

Δ 210.2 Reconditioned Equipment. The following shall not be reconditioned:

- (1) Equipment that provides ground-fault circuit-interrupter protection for personnel
- (2) Equipment that provides arc-fault circuit-interrupter protection

210.3 Other Articles for Specific-Purpose Branch Circuits. Table 210.3 lists references for specific equipment and applications not located in Chapters 5, 6, and 7 that amend or supplement the requirements of this article.

210.4 Multiwire Branch Circuits.

(A) General. Branch circuits recognized by this article shall be permitted as multiwire circuits. A multiwire circuit shall be permitted to be considered as multiple circuits. **Except as permitted in 300.3(B)(4),** all conductors of a multiwire branch circuit shall originate from the equipment containing the branch-circuit overcurrent protective device or protective devices.

Informational Note No. 1: A 3-phase, 4-wire, wye-connected power system used to supply power to nonlinear loads might necessitate that the power system design allow for the possibility of high harmonic currents on the neutral conductor.

Informational Note No. 2: See 300.13(B) for continuity of grounded conductors on multiwire circuits.

(B) Disconnecting Means. Each multiwire branch circuit shall be provided with a means that will simultaneously disconnect

Δ Table 210.3 Specific-Purpose Branch Circuits

Equipment	Article	Section
Air-conditioning and refrigerating equipment		440.6, 440.31, and 440.32
Busways		368.17
Central heating equipment other than fixed electric space-heating equipment		422.12
Fixed electric heating equipment for pipelines and vessels		427.4
Fixed electric space-heating equipment		424.4
Fixed outdoor electrical deicing and snow-melting equipment		426.4
Infrared lamp industrial heating equipment		422.48 and 424.3
Motors, motor circuits, and controllers	430	
Switchboards and panelboards		408.52

all ungrounded conductors at the point where the branch circuit originates.

Informational Note: See 240.15(B) for information on the use of single-pole circuit breakers as the disconnecting means.

(C) Line-to-Neutral Loads. Multiwire branch circuits shall supply only line-to-neutral loads.

Exception No. 1: A multiwire branch circuit that supplies only one utilization equipment shall be permitted to supply line-to-line loads.

Exception No. 2: A multiwire branch circuit shall be permitted to supply line-to-line loads if all ungrounded conductors of the multiwire branch circuit are opened simultaneously by the branch-circuit overcurrent device.

(D) Grouping. The ungrounded and grounded circuit conductors of each multiwire branch circuit shall be grouped in accordance with 200.4(B).

210.5 Identification for Branch Circuits.

(A) Grounded Conductor. The grounded conductor of a branch circuit shall be identified in accordance with 200.6.

(B) Equipment Grounding Conductor. The equipment grounding conductor shall be identified in accordance with 250.119.

(C) Identification of Ungrounded Conductors. Ungrounded conductors shall be identified in accordance with 210.5(C)(1) or (2), as applicable.

Δ (1) Branch Circuits Supplied from More Than One Nominal Voltage System. Where the premises wiring system has branch circuits supplied from more than one nominal voltage system, each ungrounded conductor of a branch circuit shall be identified by phase or line and by nominal voltage system at all termination, connection, and splice points in accordance with 210.5(C)(1)(a) and (C)(1)(b). Different systems within the same premises that have the same nominal voltage shall be permitted to use the same identification.

(a) *Means of Identification.* The means of identification shall be permitted to be by separate color coding, marking tape, tagging, or other approved means.

(b) *Posting of Identification Means.* The method used for conductors originating within each branch-circuit panelboard or similar branch-circuit distribution equipment shall be documented in a manner that is readily available or shall be permanently posted at each branch-circuit panelboard or similar branch-circuit distribution equipment. The label shall be of sufficient durability to withstand the environment involved and shall not be handwritten.

Exception: In existing installations where a voltage system(s) already exists and a different voltage system is being added, it shall be permissible to mark only the new system voltage. Existing unidentified systems shall not be required to be identified at each termination, connection, and splice point in accordance with 210.5(C)(1)(a) and (C)(1)(b). Labeling shall be required at each voltage system distribution equipment to identify that only one voltage system has been marked for a new system(s). The new system label(s) shall include the words "other unidentified systems exist on the premises."

(2) Branch Circuits Supplied from Direct-Current Systems.

Where a branch circuit is supplied from a dc system operating at more than 60 volts, each ungrounded conductor of 4 AWG or larger shall be identified by polarity at all termination, connection, and splice points by marking tape, tagging, or other approved means; each ungrounded conductor of 6 AWG or smaller shall be identified by polarity at all termination, connection, and splice points in compliance with 210.5(C)(2)(a) and (b). The identification methods utilized for conductors originating within each branch-circuit panelboard or similar branch-circuit distribution equipment shall be documented in a manner that is readily available or shall be permanently posted at each branch-circuit panelboard or similar branch-circuit distribution equipment.

(a) *Positive Polarity, Sizes 6 AWG or Smaller.* Where the positive polarity of a dc system does not serve as the connection point for the grounded conductor, each positive ungrounded conductor shall be identified by one of the following means:

- (1) A continuous red outer finish
- (2) A continuous red stripe durably marked along the conductor's entire length on insulation of a color other than green, white, gray, or black
- (3) Imprinted plus signs (+) or the word POSITIVE or POS durably marked on insulation of a color other than green, white, gray, or black and repeated at intervals not exceeding 610 mm (24 in.) in accordance with 310.8(B)
- (4) An approved permanent marking means such as sleeving or shrink-tubing that is suitable for the conductor size, at all termination, connection, and splice points, with imprinted plus signs (+) or the word POSITIVE or POS durably marked on insulation of a color other than green, white, gray, or black

(b) *Negative Polarity, Sizes 6 AWG or Smaller.* Where the negative polarity of a dc system does not serve as the connection point for the grounded conductor, each negative ungrounded conductor shall be identified by one of the following means:

- (1) A continuous black outer finish
- (2) A continuous black stripe durably marked along the conductor's entire length on insulation of a color other than green, white, gray, or red
- (3) Imprinted minus signs (−) or the word NEGATIVE or NEG durably marked on insulation of a color other than green, white, gray, or red and repeated at intervals not exceeding 610 mm (24 in.) in accordance with 310.8(B)

- (4) An approved permanent marking means such as sleeving or shrink-tubing that is suitable for the conductor size, at all termination, connection, and splice points, with imprinted minus signs (−) or the word NEGATIVE or NEG durably marked on insulation of a color other than green, white, gray, or red

210.6 Branch-Circuit Voltage Limitations. The nominal voltage of branch circuits shall not exceed the values permitted by 210.6(A) through (D).

(A) Occupancy Limitation. In dwelling units and guest rooms or guest suites of hotels, motels, and similar occupancies, the voltage shall not exceed 120 volts, nominal, between conductors that supply the terminals of the following:

- (1) Luminaires
- (2) Cord-and-plug-connected loads 1440 volt-amperes, nominal, or less or less than ¼ hp

(B) 120 Volts Between Conductors. Circuits not exceeding 120 volts, nominal, between conductors shall be permitted to supply the following:

- (1) The terminals of lampholders applied within their voltage ratings
- (2) Auxiliary equipment of electric-discharge lamps

Informational Note: See 410.137 for auxiliary equipment limitations.

- (3) Cord-and-plug-connected or permanently connected utilization equipment

(C) 277 Volts to Ground. Circuits exceeding 120 volts, nominal, between conductors and not exceeding 277 volts, nominal, to ground shall be permitted to supply cord-and-plug-connected or permanently connected utilization equipment, or the following types of listed luminaires:

- (1) Electric-discharge luminaires with integral ballasts
- (2) LED luminaires with LED drivers between the branch circuit and the lampholders
- (3) Incandescent or LED luminaires, equipped with medium-base or smaller screw shell lampholders, where the lampholders are supplied at 120 volts or less from the output of a stepdown autotransformer, LED driver, or other type of power supply that is an integral component of the luminaire

Informational Note No. 1: See 410.90 for requirements regarding the connection of screw shell lampholders to grounded conductors.

- (4) Luminaires equipped with mogul-base screw shell lampholders
- (5) Luminaires equipped with lampholders, other than the screw shell type, when used within the voltage ratings of their lampholders
- (6) Luminaires without lampholders

Informational Note No. 2: Luminaires with nonserviceable LEDs are examples of luminaires without lampholders.

- (7) Auxiliary equipment of electric-discharge or LED-type lamps

Informational Note No. 3: See 410.137 for auxiliary equipment limitations.

- (8) Luminaires converted with listed retrofit kits incorporating integral LED light sources or accepting LED lamps

that also conform with 210.6(C)(1), (C)(2), (C)(3), (C)(4), or (C)(5)

(D) 1000 Volts ac or 1500 Volts dc Between Conductors.

Circuits exceeding 277 volts, nominal, to ground and not exceeding 1000 volts ac or 1500 volts dc, nominal, between conductors shall be permitted to supply the following:

- (1) The auxiliary equipment of electric-discharge lamps mounted in permanently installed luminaires where the luminaires are mounted in accordance with one of the following:
 - a. Not less than a height of 6.7 m (22 ft) on poles or similar structures for the illumination of outdoor areas such as highways, roads, bridges, athletic fields, or parking lots
 - b. Not less than a height of 5.5 m (18 ft) on other structures such as tunnels

Informational Note: See 410.137 for auxiliary equipment limitations.

- (2) Cord-and-plug-connected or permanently connected utilization equipment other than luminaires
- (3) Luminaires powered from direct-current systems where either of the following apply:
 - a. The luminaire contains a listed, dc-rated ballast that provides isolation between the dc power source and the lamp circuit and protection from electric shock when changing lamps.
 - b. The luminaire contains a listed, dc-rated ballast and has no provision for changing lamps.

Exception No. 1 to (B), (C), and (D): For lampholders of infrared industrial heating appliances as provided in 425.14.

Exception No. 2 to (B), (C), and (D): For railway properties as described in 110.19.

210.7 Multiple Branch Circuits. If two or more branch circuits supply devices or equipment on the same yoke or mounting strap, a means to simultaneously disconnect the ungrounded supply conductors shall be provided at the point at which the branch circuits originate.

Δ 210.8 Ground-Fault Circuit-Interrupter Protection for Personnel. A listed Class A GFCI shall provide protection in accordance with 210.8(A) through (F). The GFCI shall be installed in a readily accessible location.

Informational Note: See 215.9 for GFCI protection on feeders.

For the purposes of this section, the distance from receptacles shall be measured as the shortest path the power supply cord connected to the receptacle would follow without piercing a floor, wall, ceiling, or fixed barrier.

Δ (A) Dwelling Units. All 125-volt through 250-volt receptacles installed in the following locations and supplied by single-phase branch circuits rated 150 volts or less to ground shall have ground-fault circuit-interrupter protection for personnel:

- (1) Bathrooms
- (2) Garages and also accessory buildings that have a floor located at or below grade level not intended as habitable rooms and limited to storage areas, work areas, and areas of similar use
- (3) Outdoors
- (4) Crawl spaces — at or below grade level

- (5) Basements
- (6) Kitchens
- (7) Areas with sinks and permanent provisions for food preparation, beverage preparation, or cooking
- (8) Sinks — where receptacles are installed within 1.8 m (6 ft) from the top inside edge of the bowl of the sink
- (9) Boathouses
- (10) Bathtubs or shower stalls — where receptacles are installed within 1.8 m (6 ft) of the outside edge of the bathtub or shower stall
- (11) Laundry areas
- (12) Indoor damp and wet locations

Exception No. 1: Receptacles that are not readily accessible and are supplied by a branch circuit dedicated to electric snow-melting, deicing, or pipeline and vessel heating equipment shall be permitted to be installed in accordance with 426.28 or 427.22, as applicable.

Exception No. 2: A receptacle supplying only a permanently installed premises security system shall be permitted to omit ground-fault circuit-interrupter protection.

Exception No. 3: Listed weight-supporting ceiling receptacles (WSCR) utilized in combination with compatible weight-supporting attachment fittings (WSAF) installed for the purpose of supporting a ceiling luminaire or ceiling-suspended fan shall be permitted to omit ground-fault circuit-interrupter protection. If a general-purpose convenience receptacle is integral to the ceiling luminaire or ceiling-suspended fan, GFCI protection shall be provided.

Exception No. 4: Factory-installed receptacles that are not readily accessible and are mounted internally to bathroom exhaust fan assemblies shall not require GFCI protection unless required by the installation instructions or listing.

Informational Note: See 760.41(B) and 760.121(B) for power supply requirements for fire alarm systems.

Δ (B) Other Than Dwelling Units. All 125-volt through 250-volt receptacles supplied by single-phase branch circuits rated 150 volts or less to ground, 50 amperes or less, and all receptacles supplied by three-phase branch circuits rated 150 volts or less to ground, 100 amperes or less, installed in the following locations shall be provided with GFCI protection:

- (1) Bathrooms
- (2) Kitchens
- (3) Areas with sinks and permanent provisions for food preparation, beverage preparation, or cooking
- (4) Buffet serving areas with permanent provisions for food serving, beverage serving, or cooking
- (5) Rooftops
- (6) Outdoors
- (7) Sinks where receptacles or cord-and-plug-connected fixed or stationary appliances are installed within 1.8 m (6 ft) from the top inside edge of the bowl of the sink
- (8) Indoor damp or wet locations
- (9) Locker rooms with associated showering facilities
- (10) Garages, accessory buildings, service bays, and similar areas other than vehicle exhibition halls and showrooms
- (11) Crawl spaces at or below grade level
- (12) Unfinished areas of basements
- (13) Aquariums, bait wells, and similar open aquatic vessels or containers, such as tanks or bowls, where receptacles are installed within 1.8 m (6 ft.) from the top inside edge or rim or from the conductive support framing of the vessel or container

- (14) Laundry areas
- (15) Bathtubs and shower stalls where receptacles are installed within 1.8 m (6 ft) of the outside edge of the bathtub or shower stall

Exception No. 1: Receptacles that are not readily accessible and are supplied by a branch circuit dedicated to electric snow-melting, deicing, or pipeline and vessel heating equipment shall be permitted to be installed in accordance with 426.28 or 427.22, as applicable.

Exception No. 2: Receptacles on rooftops shall not be required to be readily accessible other than from the rooftop.

Exception No. 3: Receptacles or cord-and-plug-connected fixed and stationary appliances installed within 1.8 m (6 ft) from the top inside edge of a bowl of a sink shall not be required to be GFCI protected in industrial establishments where the conditions of maintenance and supervision ensure that only qualified personnel are involved, an assured equipment grounding conductor program in accordance with 590.6(B)(2) shall be permitted for only those receptacle outlets used to supply equipment that would create a greater hazard if power is interrupted or that has a design not compatible with GFCI protection.

Exception No. 4: Receptacles or cord-and-plug-connected fixed and stationary appliances installed within 1.8 m (6 ft) from the top inside edge of a bowl of a sink shall not be required to be GFCI protected in industrial laboratories where the receptacles are used to supply equipment if removal of power would introduce a greater hazard.

Exception No. 5: Receptacles located in patient bed locations of Category 2 (general care) or Category 1 (critical care) spaces of health care facilities shall be permitted to comply with 517.21.

Exception No. 6: Listed weight-supporting ceiling receptacles (WSCR) utilized in combination with compatible weight-supporting attachment fittings (WSAF) installed for the purpose of serving a ceiling luminaire or ceiling-suspended fan shall be permitted to omit GFCI protection. If a general-purpose convenience receptacle is integral to the ceiling luminaire or ceiling-suspended fan, GFCI protection shall be provided.

(C) Crawl Space Lighting Outlets. GFCI protection shall be provided for lighting outlets not exceeding 120 volts installed in crawl spaces.

Δ (D) Specific Appliances. GFCI protection shall be provided for the branch circuit or outlet supplying the following appliances rated 150 volts or less to ground and 60 amperes or less, single- or 3-phase:

- (1) Automotive vacuum machines
- (2) Drinking water coolers and bottle fill stations
- (3) High-pressure spray washing machines
- (4) Tire inflation machines
- (5) Vending machines
- (6) Sump pumps
- (7) Dishwashers
- (8) Electric ranges
- (9) Wall-mounted ovens
- (10) Counter-mounted cooking units
- (11) Clothes dryers
- (12) Microwave ovens

(E) Equipment Requiring Servicing. GFCI protection shall be provided for the receptacles required by 210.63.

Δ (F) Outdoor Outlets. For dwellings, all outdoor outlets, other than those covered in 210.8(A), Exception No. 1, including outlets installed in the following locations, and supplied by

single-phase branch circuits rated 150 volts or less to ground, 50 amperes or less, shall be provided with GFCI protection:

- (1) Garages that have floors located at or below grade level
- (2) Accessory buildings
- (3) Boathouses

If equipment supplied by an outlet covered under the requirements of this section is replaced, the outlet shall be supplied with GFCI protection.

Exception No. 1: GFCI protection shall not be required on lighting outlets other than those covered in 210.8(C).

Exception No. 2: GFCI protection shall not be required for listed HVAC equipment. This exception shall expire September 1, 2026.

210.9 Circuits Derived from Autotransformers. Branch circuits shall not be derived from autotransformers unless the circuit supplied has a grounded conductor that is electrically connected to a grounded conductor of the system supplying the autotransformer.

Exception No. 1: An autotransformer shall be permitted without the connection to a grounded conductor where transforming from a nominal 208 volts to a nominal 240-volt supply or similarly from 240 volts to 208 volts.

Exception No. 2: In industrial occupancies, where conditions of maintenance and supervision ensure that only qualified persons service the installation, autotransformers shall be permitted to supply nominal 600-volt loads from nominal 480-volt systems, and 480-volt loads from nominal 600-volt systems, without the connection to a similar grounded conductor.

210.10 Ungrounded Conductors Tapped from Grounded Systems. Two-wire dc circuits and ac circuits of two or more ungrounded conductors shall be permitted to be tapped from the ungrounded conductors of circuits that have a grounded neutral conductor. Switching devices in each tapped circuit shall have a pole in each ungrounded conductor. All poles of multipole switching devices shall manually switch together where such switching devices also serve as a disconnecting means as required by the following:

- (1) 410.93 for double-pole switched lampholders
- (2) 410.104(B) for electric-discharge lamp auxiliary equipment switching devices
- (3) 422.31(B) for an appliance
- (4) 424.20 for a fixed electric space-heating unit
- (5) 426.51 for electric deicing and snow-melting equipment
- (6) 430.85 for a motor controller
- (7) 430.103 for a motor

210.11 Branch Circuits Required. Branch circuits for lighting and for appliances, including motor-operated appliances, shall be provided to supply the loads calculated in accordance with 220.10. In addition, branch circuits shall be provided for specific loads not covered by 220.10 where required elsewhere in this Code and for dwelling unit loads as specified in 210.11(C).

(A) Number of Branch Circuits. The minimum number of branch circuits shall be determined from the total calculated load and the size or rating of the circuits used. In all installations, the number of circuits shall be sufficient to supply the load served. In no case shall the load on any circuit exceed the maximum specified by 220.11.

(B) Load Evenly Proportioned Among Branch Circuits. Where the load is calculated on the basis of volt-amperes per square meter or per square foot, the wiring system up to and including the branch-circuit panelboard(s) shall be provided to serve not less than the calculated load. This load shall be evenly proportioned among multioutlet branch circuits within the panelboard(s). Branch-circuit overcurrent devices and circuits shall be required to be installed only to serve the connected load.

(C) Dwelling Units.

(1) Small-Appliance Branch Circuits. In addition to the number of branch circuits required by other parts of this section, two or more 20-ampere small-appliance branch circuits shall be provided for all receptacle outlets specified by 210.52(B).

(2) Laundry Branch Circuits. In addition to the number of branch circuits required by other parts of this section, at least one additional 20-ampere branch circuit shall be provided to supply the laundry receptacle outlet(s) required by 210.52(F). This circuit shall have no other outlets.

(3) Bathroom Branch Circuits. In addition to the number of branch circuits required by other parts of this section, one or more 120-volt, 20-ampere branch circuit shall be provided to supply bathroom(s) receptacle outlet(s) required by 210.52(D) and any countertop and similar work surface receptacle outlets. Such circuits shall have no other outlets.

Exception: Where the 20-ampere circuit supplies a single bathroom, outlets for other equipment within the same bathroom shall be permitted to be supplied in accordance with 210.23(B)(1) and (B)(2).

Δ (4) Garage Branch Circuits. In addition to the number of branch circuits required by other parts of this section, at least one 120-volt, 20-ampere branch circuit shall be installed to supply receptacle outlets, including those required by 210.52(G)(1) for attached garages and in detached garages with electric power. This circuit shall have no other outlets.

Additional branch circuits rated 15 amperes or greater shall be permitted to serve receptacle outlets other than those required by 210.52(G)(1).

Exception No. 1: This circuit shall be permitted to supply outdoor receptacle outlets.

Exception No. 2: Where the 20-ampere circuit supplies a single vehicle bay garage, outlets for other equipment within the same garage shall be permitted to be supplied in accordance with 210.23(B)(1) and (B)(2).

210.12 Arc-Fault Circuit-Interrupter Protection. Arc-fault circuit-interrupter (AFCI) protection shall be installed in accordance with 210.12(B) through (E) by any of the means described in 210.12(A)(1) through (A)(6). The AFCI shall be listed and installed in a readily accessible location.

Δ (A) Means of Protection. AFCI protection shall be provided by any of the following means:

- (1) A listed combination-type AFCI installed to provide protection of the entire branch circuit.
- (2) A listed branch/feeder-type AFCI installed at the origin of the branch circuit in combination with a listed outlet branch-circuit-type AFCI installed on the branch circuit at the first outlet box, which shall be marked to indicate that it is the first outlet of the branch circuit.
- (3) A listed supplemental arc protection circuit breaker installed at the origin of the branch circuit in combina-

tion with a listed outlet branch-circuit-type AFCI installed on the branch circuit at the first outlet box if all of the following conditions are met:

- a. The branch-circuit wiring shall be continuous from the branch-circuit overcurrent device to the outlet branch-circuit AFCI.
 - b. The maximum length of the branch-circuit wiring from the branch-circuit overcurrent device to the first outlet shall not exceed 15.2 m (50 ft) for a 14 AWG conductor or 21.3 m (70 ft) for a 12 AWG conductor.
 - c. The first outlet box shall be marked to indicate that it is the first outlet of the branch circuit.
- (4)** A listed outlet branch-circuit-type AFCI installed on the branch circuit at the first outlet in combination with a listed branch-circuit overcurrent protective device if all of the following conditions are met:
- a. The branch-circuit wiring shall be continuous from the branch-circuit overcurrent device to the outlet branch-circuit AFCI.
 - b. The maximum length of the branch-circuit wiring from the branch-circuit overcurrent device to the first outlet shall not exceed 15.2 m (50 ft) for a 14 AWG conductor or 21.3 m (70 ft) for a 12 AWG conductor.
 - c. The first outlet box shall be marked to indicate that it is the first outlet of the branch circuit.
 - d. The combination of the branch-circuit overcurrent device and outlet branch-circuit AFCI shall be identified as meeting the requirements for a system combination-type AFCI and listed as such.
- (5)** If metal raceway, metal wireways, metal auxiliary gutters, or Type MC or Type AC cable meeting the applicable requirements of 250.118, with metal boxes, metal conduit bodies, and metal enclosures are installed for the portion of the branch circuit between the branch-circuit overcurrent device and the first outlet, it shall be permitted to install a listed outlet branch-circuit-type AFCI at the first outlet to provide protection for the remaining portion of the branch circuit.
- (6)** Where a listed metal or nonmetallic conduit or tubing or Type MC cable is encased in not less than 50 mm (2 in.) of concrete for the portion of the branch circuit between the branch-circuit overcurrent device and the first outlet, it shall be permitted to install a listed outlet branch-circuit-type AFCI at the first outlet to provide protection for the remaining portion of the branch circuit.

Informational Note: See UL 1699-2011, *Standard for Arc-Fault Circuit-Interrupters*, for information on combination-type and branch/feeder-type AFCI devices. See UL Subject 1699A, *Outline of Investigation for Outlet Branch Circuit Arc-Fault Circuit-Interrupters*, for information on outlet branch-circuit type AFCI devices. See UL Subject 1699C, *Outline of Investigation for System Combination Arc-Fault Circuit Interrupters*, for information on system combination AFCIs.

N (B) Dwelling Units. All 120-volt, single-phase, 10-, 15-, and 20-ampere branch circuits supplying outlets or devices installed in the following locations shall be protected by any of the means described in 210.12(A)(1) through (A)(6):

- (1) Kitchens
- (2) Family rooms
- (3) Dining rooms
- (4) Living rooms
- (5) Parlors
- (6) Libraries

- (7) Dens
- (8) Bedrooms
- (9) Sunrooms
- (10) Recreation rooms
- (11) Closets
- (12) Hallways
- (13) Laundry areas
- (14) Similar areas

Exception No. 1: AFCI protection shall not be required for an individual branch circuit supplying a fire alarm system installed in accordance with 760.41(B) or 760.121(B). The branch circuit shall be installed in a metal raceway, metal auxiliary gutter, steel-armored cable, or Type MC or Type AC cable meeting the applicable requirements of 250.118, with metal boxes, conduit bodies, and enclosures.

Exception No. 2: AFCI protection shall not be required for the individual branch circuit supplying an outlet for arc welding equipment in a dwelling unit until January 1, 2025.

Informational Note No. 1: See NFPA 72-2022, *National Fire Alarm and Signaling Code*, 29.9.4(5), for information on secondary power source requirements for smoke alarms installed in dwelling units.

Informational Note No. 2: See 760.41(B) and 760.121(B) for power source requirements for fire alarm systems.

(C) Dormitory Units. All 120-volt, single-phase, 10-, 15-, and 20-ampere branch circuits supplying outlets or devices installed in the following locations shall be protected by any of the means described in 210.12(A)(1) through (A)(6):

- (1) Bedrooms
- (2) Living rooms
- (3) Hallways
- (4) Closets
- (5) Bathrooms
- (6) Similar rooms

(D) Other Occupancies. All 120-volt, single-phase, 10-, 15-, and 20-ampere branch circuits supplying outlets or devices installed in the following locations shall be protected by any of the means described in 210.12(A)(1) through (A)(6):

- (1) Guest rooms and guest suites of hotels and motels
- (2) Areas used exclusively as patient sleeping rooms in nursing homes and limited-care facilities
- (3) Areas designed for use exclusively as sleeping quarters in fire stations, police stations, ambulance stations, rescue stations, ranger stations, and similar locations

Δ (E) Branch Circuit Wiring Extensions, Modifications, or Replacements. If branch-circuit wiring for any of the areas specified in 210.12(B), (C), or (D) is modified, replaced, or extended, the branch circuit shall be protected by one of the following:

- (1) By any of the means described in 210.12(A)(1) through (A)(6)
- (2) A listed outlet branch-circuit-type AFCI located at the first receptacle outlet of the existing branch circuit

Exception: AFCI protection shall not be required where the extension of the existing branch-circuit conductors is not more than 1.8 m (6 ft) and does not include any additional outlets or devices, other than splicing devices. This measurement shall not include the conductors inside an enclosure, cabinet, or junction box.

Δ 210.13 Ground-Fault Protection of Equipment. Each branch-circuit disconnecting means rated 1000 amperes or more and

installed on solidly grounded wye electrical systems of more than 150 volts to ground, but not exceeding 1000 volts phase-to-phase, shall be provided with ground-fault protection of equipment in accordance with 230.95.

Informational Note: See 517.17 for requirements on buildings that contain health care occupancies.

Exception No. 1: This section shall not apply to a disconnecting means for a continuous industrial process where a nonorderly shutdown will introduce additional or increased hazards.

Exception No. 2: This section shall not apply if ground-fault protection of equipment is provided on the supply side of the branch circuit and on the load side of any transformer supplying the branch circuit.

210.17 Guest Rooms and Guest Suites. Guest rooms and guest suites in the following occupancies that are provided with permanent provisions for cooking shall have branch circuits installed to meet the rules for dwelling units:

- (1) Hotels
- (2) Motels
- (3) Assisted living facilities

Informational Note No. 1: See 210.11(C)(2) and 210.52(F), Exception No. 2, for information on laundry branch circuits and receptacle outlets.

Informational Note No. 2: See NFPA 101-2021, *Life Safety Code*, 3.3.198.12 and A.3.3.198.12(5), for the definition of assisted living facilities.

Part II. Branch-Circuit Ratings

210.18 Rating. Branch circuits recognized by this article shall be rated in accordance with the maximum permitted ampere rating or setting of the overcurrent device. The rating for other than individual branch circuits shall be 10, 15, 20, 30, 40, and 50 amperes. Where conductors of higher ampacity are used for any reason, the ampere rating or setting of the specified overcurrent device shall determine the circuit rating.

Exception No. 1: Multioutlet branch circuits greater than 50 amperes shall be permitted to supply nonlighting outlet loads in locations where conditions of maintenance and supervision ensure that only qualified persons service the equipment.

Exception No. 2: Branch circuits rated 10 amperes shall not supply receptacle outlets.

210.19 Conductors — Minimum Ampacity and Size. Branch-circuit conductors for circuits not exceeding 1000 volts ac or 1500 volts dc shall be sized in accordance with 210.19(A) through (D).

Informational Note: Conductors for branch circuits as defined in Article 100, sized to prevent a voltage drop exceeding 3 percent at the farthest outlet of power, heating, and lighting loads, or combinations of such loads, and where the maximum total voltage drop on both feeders and branch circuits to the farthest outlet does not exceed 5 percent, provide reasonable efficiency of operation. See 215.2(A)(2), Informational Note No. 2, for information on voltage drop on feeder conductors.

Δ (A) General. Branch-circuit conductors shall have an ampacity not less than the larger of the following and comply with 110.14(C) for equipment terminations:

- (1) Where a branch circuit supplies continuous loads or any combination of continuous and noncontinuous loads, the

minimum branch-circuit conductor size shall have an ampacity not less than the noncontinuous load plus 125 percent of the continuous load in accordance with 310.14.

Exception to (1): If the assembly, including the overcurrent devices protecting the branch circuits, is listed for operation at 100 percent of its rating, the ampacity of the branch-circuit conductors shall be permitted to be not less than the sum of the continuous load plus the noncontinuous load in accordance with 110.14(C).

- (2) The minimum branch-circuit conductor size shall have an ampacity not less than the maximum load to be served after the application of any adjustment or correction factors in accordance with 310.15.

Exception to (1) and (2): Where a portion of a branch circuit is connected at both its supply and load ends to separately installed pressure connections as covered in 110.14(C)(2), an allowable ampacity in accordance with 310.15 not less than the sum of the continuous load plus the noncontinuous load shall be permitted. No portion of a branch circuit installed under this exception shall extend into an enclosure containing either the branch-circuit supply or the branch-circuit load terminations.

(B) Branch Circuits with More than One Receptacle. Conductors of branch circuits supplying more than one receptacle for cord-and-plug-connected portable loads shall have an ampacity of not less than the rating of the branch circuit.

(C) Household Ranges and Cooking Appliances. Branch-circuit conductors supplying household ranges, wall-mounted ovens, counter-mounted cooking units, and other household cooking appliances shall have an ampacity not less than the rating of the branch circuit and not less than the maximum load to be served. For ranges of 8¾ kW or more rating, the minimum branch-circuit rating shall be 40 amperes.

Exception No. 1: Conductors tapped from a branch circuit not exceeding 50 amperes supplying electric ranges, wall-mounted electric ovens, and counter-mounted electric cooking units shall have an ampacity of not less than 20 amperes and shall be sufficient for the load to be served. These tap conductors include any conductors that are a part of the leads supplied with the appliance that are smaller than the branch-circuit conductors. The taps shall not be longer than necessary for servicing the appliance.

Exception No. 2: The neutral conductor of a 3-wire branch circuit supplying a household electric range, a wall-mounted oven, or a counter-mounted cooking unit shall be permitted to be smaller than the ungrounded conductors where the maximum demand of a range of 8¾ kW or more rating has been calculated according to Column C of Table 220.55, but such conductor shall have an ampacity of not less than 70 percent of the branch-circuit rating and shall not be smaller than 10 AWG.

(D) Other Loads. Branch-circuit conductors that supply loads other than those specified in 210.3 and other than cooking appliances as covered in 210.19(C) shall have an ampacity sufficient for the loads served and shall not be smaller than 14 AWG.

Exception No. 1: Tap conductors shall have an ampacity sufficient for the load served. In addition, they shall have an ampacity of not less than 15 for circuits rated less than 40 amperes and not less than 20 for circuits rated at 40 or 50 amperes and only where these tap conductors supply any of the following loads:

- (1) *Individual lampholders or luminaires with taps extending not longer than 450 mm (18 in.) beyond any portion of the lampholder or luminaire*
- (2) *A luminaire having tap conductors in accordance with 410.117*
- (3) *Individual outlets, other than receptacle outlets, with taps not over 450 mm (18 in.) long*
- (4) *Infrared lamp industrial heating appliances*
- (5) *Nonheating leads of deicing and snow-melting cables and mats*

Exception No. 2: Fixture wires and flexible cords shall be permitted to be smaller than 14 AWG as permitted by 240.5.

210.20 Overcurrent Protection. Branch-circuit conductors and equipment for circuits not exceeding 1000 volts ac or 1500 volts dc shall be protected by overcurrent protective devices that have a rating or setting that complies with 210.20(A) through (D).

(A) Continuous and Noncontinuous Loads. Where a branch circuit supplies continuous loads or any combination of continuous and noncontinuous loads, the rating of the overcurrent device shall not be less than the noncontinuous load plus 125 percent of the continuous load.

Exception: Where the assembly, including the overcurrent devices protecting the branch circuit(s), is listed for operation at 100 percent of its rating, the ampere rating of the overcurrent device shall be permitted to be not less than the sum of the continuous load plus the noncontinuous load.

(B) Conductor Protection. Conductors shall be protected in accordance with 240.4. Flexible cords and fixture wires shall be protected in accordance with 240.5.

(C) Equipment. The rating or setting of the overcurrent protective device shall not exceed that specified in the applicable articles referenced in Table 240.3 for equipment.

(D) Outlet Devices. The rating or setting shall not exceed that specified in 210.21 for outlet devices.

210.21 Outlet Devices. Outlet devices shall have an ampere rating that is not less than the load to be served and shall comply with 210.21(A) and (B).

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

(B) Receptacles.

- Δ (1) Single Receptacle on an Individual Branch Circuit.** A single receptacle installed on an individual branch circuit shall have an ampere rating not less than that of the branch circuit.

Exception No. 1: A receptacle installed in accordance with 430.81(B).

Exception No. 2: A receptacle installed exclusively for the use of a cord-and-plug-connected arc welder shall be permitted to have an ampere rating not less than the minimum branch-circuit conductor ampacity determined by 630.11(A) for arc welders.

Informational Note: See **Article 100** for the definition of **receptacle**.

(2) **Total Cord-and-Plug-Connected Load.** Where connected to a branch circuit supplying two or more receptacles or outlets, a receptacle shall not supply a total cord-and-plug-connected load in excess of the maximum specified in Table 210.21(B)(2).

Δ (3) **Receptacle Ratings.** Where connected to a branch circuit supplying two or more receptacles or outlets, receptacle ratings shall not be less than the values listed in Table 210.21(B)(3), or, where rated higher than 50 amperes, the receptacle rating shall not be less than the branch-circuit rating.

Exception No. 1: Receptacles installed exclusively for the use of cord-and-plug-connected arc welders shall be permitted to have ampere ratings not less than the minimum branch-circuit conductor ampacity determined by 630.11(A) or (B) for arc welders.

Exception No. 2: The ampere rating of a receptacle installed for electric discharge lighting shall be permitted to be based on 410.62(C).

(4) **Range Receptacle Rating.** The ampere rating of a range receptacle shall be permitted to be based on a single range demand load as specified in Table 220.55.

210.22 Permissible Loads, Individual Branch Circuits. An individual branch circuit shall be permitted to supply any load for which it is rated, but in no case shall the load exceed the branch-circuit ampere rating.

Δ **210.23 Permissible Loads, Multiple-Outlet Branch Circuits.** In no case shall the load exceed the branch-circuit ampere rating. A branch circuit supplying two or more outlets or receptacles shall supply only the loads specified according to its size in accordance with 210.23(A) through (E) and as summarized in 210.24.

N (A) **10-Ampere Branch Circuits.** A 10-ampere branch circuit shall comply with the requirements of 210.23(A)(1) and (A)(2).

N (1) **Loads Permitted for 10-Ampere Branch Circuits.** A 10-ampere branch circuit shall be permitted to supply one or more of the following:

- (1) Lighting outlets

Table 210.21(B)(2) Maximum Cord-and-Plug-Connected Load to Receptacle

Circuit Rating (Amperes)	Receptacle Rating (Amperes)	Maximum Load (Amperes)
15 or 20	15	12
20	20	16
30	30	24

Δ **Table 210.21(B)(3) Receptacle Ratings for Circuits Serving More Than One Receptacle or Receptacle Outlet**

Circuit Rating (Amperes)	Receptacle Rating (Amperes)
15	15
20	15 or 20
30	30
40	40 or 50
50	50

- (2) Dwelling unit exhaust fans on bathroom or laundry room lighting circuits
- (3) A gas fireplace unit supplied by an individual branch circuit

N (2) **Loads Not Permitted for 10-Ampere Branch Circuits.** A 10-ampere branch circuit shall not supply any of the following:

- (1) Receptacle outlets
- (2) Fixed appliances, except as permitted for individual branch circuits
- (3) Garage door openers
- (4) Laundry equipment

(B) **15- and 20-Ampere Branch Circuits.** A 15- or 20-ampere branch circuit shall be permitted to supply lighting outlets, lighting units, or other utilization equipment, or any combination of them, and shall comply with 210.23(B)(1) and (B)(2).

Exception: The small-appliance branch circuits, laundry branch circuits, and bathroom branch circuits required in a dwelling unit(s) by 210.11(C)(1), (C)(2), and (C)(3) shall supply only the receptacle outlets specified in that section.

(1) **Cord-and-Plug-Connected Equipment Not Fastened in Place.** The rating of any one cord-and-plug-connected utilization equipment not fastened in place shall not exceed 80 percent of the branch-circuit ampere rating.

(2) **Utilization Equipment Fastened in Place.** The total rating of utilization equipment fastened in place, other than luminaires, shall not exceed 50 percent of the branch-circuit ampere rating where lighting units, cord-and-plug-connected utilization equipment not fastened in place, or both, are also supplied.

(C) **30-Ampere Branch Circuits.** A 30-ampere branch circuit shall be permitted to supply fixed lighting units with heavy-duty lampholders in other than a dwelling unit(s) or utilization equipment in any occupancy. The rating of any one cord-and-plug-connected utilization equipment shall not exceed 80 percent of the branch-circuit ampere rating.

(D) **40- and 50-Ampere Branch Circuits.** A 40- or 50-ampere branch circuit shall be permitted to supply cooking appliances that are fastened in place in any occupancy. In other than dwelling units, such circuits shall be permitted to supply fixed lighting units with heavy-duty lampholders, infrared heating units, or other utilization equipment.

(E) **Branch Circuits Larger Than 50 Amperes.** Branch circuits larger than 50 amperes shall supply only nonlighting outlet loads.

210.24 Branch-Circuit Requirements — Summary. The requirements for circuits that have two or more outlets or receptacles, other than the receptacle circuits of 210.11(C)(1), (C)(2), and (C)(3), are summarized in Table 210.24(1) for copper conductors and Table 210.24(2) for aluminum and copper-clad aluminum conductors. Table 210.24(1) and Table 210.24(2) provide only a summary of minimum requirements. See 210.19, 210.20, and 210.21 for the specific requirements applying to branch circuits.

210.25 Branch Circuits in Buildings with More Than One Occupancy.

(A) **Dwelling Unit Branch Circuits.** Branch circuits in each dwelling unit shall supply only loads within that dwelling unit or loads associated only with that dwelling unit.

Table 210.24(1) Summary of Branch-Circuit Requirements — Copper Conductors

Circuit Rating	10 A	15 A	20 A	30 A	40 A	50 A
Conductors (min. size):						
Circuit wires	14	14	12	10	8	6
Taps	14	14	14	14	12	12
Fixture wires and cords			See 240.5.			
Overcurrent Protection	10 A	15 A	20 A	30 A	40 A	50 A
Outlet devices:						
Lampholders permitted	Any type	Any type	Any type	Heavy duty	Heavy duty	Heavy duty
Receptacle rating ¹	Not applicable ²	15 max. A	15 A or 20 A	30 A	40 A or 50 A	50 A
Maximum Load	10 A	15 A	20 A	30 A	40 A	50 A
Permissible load	See 210.23(A).	See 210.23(B).	See 210.23(B).	See 210.23(C).	See 210.23(D).	See 210.23(D).

¹For receptacle rating of cord-connected electric-discharge luminaires, see 410.62(C).²Branch circuits rated 10-amperes shall not supply receptacle outlets.**Table 210.24(2) Summary of Branch-Circuit Requirements — Aluminum and Copper-Clad Aluminum Conductors**

Circuit Rating	10 A	15 A	20 A	30 A	40 A	50 A
Conductors (min. size):						
Circuit wires	12	12	10	8	6	4
Taps	12	12	12	12	10	10
Fixture wires and cords				See 240.5.		
Overcurrent Protection	10 A	15 A	20 A	30 A	40 A	50 A
Outlet devices:						
Lampholders permitted	Any type	Any type	Any type	Heavy duty	Heavy duty	Heavy duty
Receptacle rating ¹	Not applicable ²	15 max. A	15 A or 20 A	30 A	40 A or 50 A	50 A
Maximum Load	10 A	15 A	20 A	30 A	40 A	50 A
Permissible load	See 210.23(A).	See 210.23(B).	See 210.23(B).	See 210.23(C).	See 210.23(D).	See 210.23(D).

¹For receptacle rating of cord-connected electric-discharge luminaires, see 410.62(C).²Branch circuits rated 10-amperes shall not supply receptacle outlets.

(B) Common Area Branch Circuits. Branch circuits installed for lighting, central alarm, signal, communications, or other purposes for public or common areas of a two-family dwelling, a multifamily dwelling, or a multi-occupancy building shall not be supplied from equipment that supplies an individual dwelling unit or tenant space.

Informational Note: Examples of public or common areas include, but are not limited to, lobbies, corridors, stairways, laundry rooms, roofs, elevators, washrooms, store rooms, drive-ways (parking), and mechanical rooms.

Part III. Required Outlets

210.50 Receptacle Outlets. Receptacle outlets shall be installed as specified in 210.52 through 210.65.

Informational Note: See Informative Annex J for information regarding ADA accessibility design.

(A) Cord Pendants. A cord connector that is supplied by a permanently connected cord pendant shall be considered a receptacle outlet.

(B) Cord Connections. A receptacle outlet shall be installed wherever flexible cords with attachment plugs are used. Where flexible cords are permitted to be permanently connected, receptacles shall be permitted to be omitted for such cords.

(C) Appliance Receptacle Outlets. Appliance receptacle outlets installed in a dwelling unit for specific appliances, such as laundry equipment, shall be installed within 1.8 m (6 ft) of the intended location of the appliance.

210.52 Dwelling Unit Receptacle Outlets. This section provides requirements for 125-volt, 15- and 20-ampere receptacle outlets. The receptacles required by this section shall be in addition to any receptacle that is as follows:

- (1) Part of a luminaire or appliance, or
- (2) Controlled by a listed wall-mounted control device in accordance with 210.70(A)(1), Exception No. 1, or
- (3) Located within cabinets or cupboards, or
- (4) Located more than 1.7 m (5½ ft) above the floor

Permanently installed electric baseboard heaters equipped with factory-installed receptacle outlets or outlets provided as a separate assembly by the manufacturer shall be permitted as the required outlet or outlets for the wall space utilized by such permanently installed heaters. Such receptacle outlets shall not be connected to the heater circuits.

Informational Note: Listed baseboard heaters include instructions that may not permit their installation below receptacle outlets.

(A) General Provisions. In every kitchen, family room, dining room, living room, parlor, library, den, sunroom, bedroom,

recreation room, or similar room or area of dwelling units, receptacle outlets shall be installed in accordance with the general provisions specified in 210.52(A)(1) through (A)(4).

(1) **Spacing.** Receptacles shall be installed such that no point measured horizontally along the floor line of any wall space is more than 1.8 m (6 ft) from a receptacle outlet.

(2) **Wall Space.** As used in this section, a wall space shall include the following:

- (1) Any space 600 mm (2 ft) or more in width (including space measured around corners) and unbroken along the floor line by doorways and similar openings, fireplaces, stationary appliances, and fixed cabinets that do not have countertops or similar work surfaces
- (2) The space occupied by fixed panels in walls, excluding sliding panels
- (3) The space afforded by fixed room dividers, such as free-standing bar-type counters or railings

(3) **Floor Receptacles.** Receptacle outlets in or on floors shall not be counted as part of the required number of receptacle outlets unless located within 450 mm (18 in.) of the wall.

(4) **Countertop and Similar Work Surface Receptacle Outlets.** Receptacles installed for countertop and similar work surfaces as specified in 210.52(C) shall not be considered as the receptacle outlets required by 210.52(A).

(B) Small Appliances.

▲ (1) **Receptacle Outlets Served.** In the kitchen, pantry, breakfast room, dining room, or similar area of a dwelling unit, the two or more 20-ampere small-appliance branch circuits required by 210.11(C)(1) shall serve all wall and floor receptacle outlets covered by 210.52(A), all countertop outlets covered by 210.52(C), and receptacle outlets for refrigeration equipment.

Exception No. 1: In addition to the required receptacles specified by 210.52, switched receptacles supplied from a general-purpose 15- or 20-ampere branch circuit shall be permitted in accordance with 210.70(A)(1), Exception No. 1.

Exception No. 2: In addition to the required receptacles specified by 210.52, a receptacle outlet to serve a specific appliance shall be permitted to be supplied from an individual branch circuit rated 15 amperes or greater.

(2) **No Other Outlets.** The two or more small-appliance branch circuits specified in 210.52(B)(1) shall have no other outlets.

Exception No. 1: A receptacle installed solely for the electrical supply to and support of an electric clock in any of the rooms specified in 210.52(B)(1) shall be permitted to be served by a small-appliance branch circuit.

Exception No. 2: Receptacles installed to provide power for supplemental equipment and lighting on gas-fired ranges, ovens, or counter-mounted cooking units shall be permitted to be served by a small-appliance branch circuit.

(3) **Kitchen Receptacle Requirements.** Receptacles installed in a kitchen to serve countertop surfaces shall be supplied by not fewer than two small-appliance branch circuits, either or both of which shall also be permitted to supply receptacle outlets in the same kitchen and in other rooms specified in 210.52(B)(1). Additional small-appliance branch circuits shall be permitted

to supply receptacle outlets in the kitchen and other rooms specified in 210.52(B)(1). No small-appliance branch circuit shall serve more than one kitchen.

(C) **Countertops and Work Surfaces.** In kitchens, pantries, breakfast rooms, dining rooms, and similar areas of dwelling units, receptacle outlets for countertop and work surfaces that are 300 mm (12 in.) or wider shall be installed in accordance with 210.52(C)(1) through (C)(3) and shall not be considered as the receptacle outlets required by 210.52(A).

For the purposes of this section, where using multioutlet assemblies, each 300 mm (12 in.) of multioutlet assembly containing two or more receptacles installed in individual or continuous lengths shall be considered to be one receptacle outlet.

(1) **Wall Spaces.** Receptacle outlets shall be installed so that no point along the wall line is more than 600 mm (24 in.) measured horizontally from a receptacle outlet in that space. The location of the receptacles shall be in accordance with 210.52(C)(3).

Exception No. 1: Receptacle outlets shall not be required directly behind a range, counter-mounted cooking unit, or sink in the installation described in Figure 210.52(C)(1).

Exception No. 2: Where a required receptacle outlet cannot be installed in the wall areas shown in Figure 210.52(C)(1), the receptacle outlet shall be permitted to be installed as close as practicable to the countertop area to be served. The total number of receptacle outlets serving the countertop shall not be less than the number needed to satisfy 210.52(C)(1). These outlets shall be located in accordance with 210.52(C)(3).

▲ (2) **Island and Peninsular Countertops and Work Surfaces.** Receptacle outlets, if installed to serve an island or peninsular countertop or work surface, shall be installed in accordance with 210.52(C)(3). If a receptacle outlet is not provided to serve an island or peninsular countertop or work surface, provisions shall be provided at the island or peninsula for future addition of a receptacle outlet to serve the island or peninsular countertop or work surface.

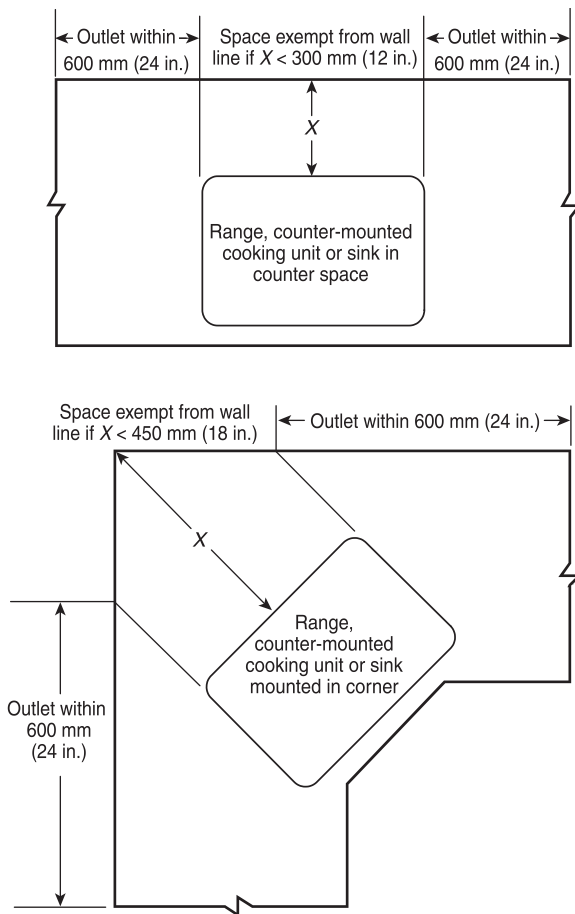
▲ (3) **Receptacle Outlet Location.** Receptacle outlets shall be located in one or more of the following:

- (1) On or above, but not more than 500 mm (20 in.) above, a countertop or work surface
- (2) In a countertop using receptacle outlet assemblies listed for use in countertops
- (3) In a work surface using receptacle outlet assemblies listed for use in work surfaces or listed for use in countertops

Receptacle outlets rendered not readily accessible by appliances fastened in place, appliance garages, sinks, or rangetops as covered in 210.52(C)(1), Exception No. 1, or appliances occupying assigned spaces shall not be considered as these required outlets.

Informational Note No. 1: See 406.5(E) for installation of receptacles in countertops and 406.5(F) for installation of receptacles in work surfaces. See 380.10 for installation of multioutlet assemblies.

Informational Note No. 2: See Informative Annex J and ANSI/ICC A117.1-2009, *Standard on Accessible and Usable Buildings and Facilities*, for additional information.



▲ FIGURE 210.52(C)(1) Determination of Area Behind a Range, Counter-Mounted Cooking Unit, or Sink.

(D) Bathrooms. At least one receptacle outlet shall be installed in bathrooms within 900 mm (3 ft) of the outside edge of each sink. The receptacle outlet shall be located on a wall or partition that is adjacent to the sink or sink countertop, located on the countertop, or installed on the side or face of the sink cabinet. In no case shall the receptacle be located more than 300 mm (12 in.) below the top of the sink or sink countertop. Receptacle outlet assemblies listed for use in countertops shall be permitted to be installed in the countertop.

Informational Note: See 406.5(E) and 406.5(G) for requirements on installation of receptacles in countertops.

▲ **(E) Outdoor Outlets.** Outdoor receptacle outlets shall be installed in accordance with 210.52(E)(1) through (E)(3).

(1) One-Family and Two-Family Dwellings. For a one-family dwelling and each unit of a two-family dwelling that is at grade level, at least one receptacle outlet readily accessible from grade and not more than 2.0 m (6½ ft) above grade level shall be installed at the front and back of the dwelling.

(2) Multifamily Dwellings. For each dwelling unit of a multifamily dwelling where the dwelling unit is located at grade level and provided with individual exterior entrance/egress, at least one receptacle outlet readily accessible from grade and not more than 2.0 m (6½ ft) above grade level shall be installed.

(3) Balconies, Decks, and Porches. Balconies, decks, and porches that are within 102 mm (4 in.) horizontally of the dwelling unit shall have at least one receptacle outlet accessible from the balcony, deck, or porch. The receptacle outlet shall not be located more than 2.0 m (6½ ft) above the balcony, deck, or porch walking surface.

(F) Laundry Areas. In dwelling units, at least one receptacle outlet shall be installed in areas designated for the installation of laundry equipment.

Exception No. 1: A receptacle for laundry equipment shall not be required in a dwelling unit of a multifamily building where laundry facilities are provided on the premises for use by all building occupants.

Exception No. 2: A receptacle for laundry equipment shall not be required in other than one-family dwellings where laundry facilities are not to be installed or permitted.

(G) Basements, Garages, and Accessory Buildings. For one- and two-family dwellings, and multifamily dwellings, at least one receptacle outlet shall be installed in the areas specified in 210.52(G)(1) through (G)(3). These receptacles shall be in addition to receptacles required for specific equipment. Receptacles supplying only a permanently installed premises security system shall not be considered as meeting these requirements.

(1) Garages. In each attached garage and in each detached garage with electric power, at least one receptacle outlet shall be installed in each vehicle bay and not more than 1.7 m (5½ ft) above the floor.

Exception: Garage spaces not attached to an individual dwelling unit of a multifamily dwelling shall not require a receptacle outlet in each vehicle bay.

(2) Accessory Buildings. In each accessory building with electric power.

(3) Basements. In each separate unfinished portion of a basement.

(H) Hallways. In dwelling units, hallways of 3.0 m (10 ft) or more in length shall have at least one receptacle outlet.

As used in this subsection, the hallway length shall be considered the length along the centerline of the hallway without passing through a doorway.

(I) Foyers. Foyers that are not part of a hallway in accordance with 210.52(H) and that have an area that is greater than 5.6 m² (60 ft²) shall have a receptacle(s) located in each wall space 900 mm (3 ft) or more in width. Doorways, door-side windows that extend to the floor, and similar openings shall not be considered wall space.

210.60 Guest Rooms, Guest Suites, Dormitory Units, and Similar Occupancies.

(A) General. Guest rooms or guest suites in hotels or motels, sleeping rooms in dormitory units, and similar occupancies shall have receptacle outlets installed in accordance with 210.52(A) and (D). Guest rooms or guest suites provided with permanent provisions for cooking shall have receptacle outlets installed in accordance with all of the applicable rules in 210.52.

(B) Receptacle Placement. The total number of receptacle outlets shall not be less than required in 210.52(A). These receptacle outlets shall be permitted to be located conveniently

for permanent furniture layout. At least two receptacle outlets shall be readily accessible. Where receptacles are installed behind the bed, the receptacle shall be located to prevent the bed from contacting any attachment plug that may be installed or the receptacle shall be provided with a suitable guard.

210.62 Show Windows. At least one 125-volt, single-phase, 15- or 20-ampere-rated receptacle outlet shall be installed within 450 mm (18 in.) of the top of each show window. No point along the top of the window shall be farther than 1.8 m (6 ft) from a receptacle outlet.

210.63 Equipment Requiring Servicing. A 125-volt, single-phase, 15- or 20-ampere-rated receptacle outlet shall be installed at an accessible location within 7.5 m (25 ft) of the equipment as specified in 210.63(A) and (B).

Informational Note: See 210.8(E) for requirements on GFCI protection.

(A) Heating, Air-Conditioning, and Refrigeration Equipment. The required receptacle outlet shall be located on the same level as the heating, air-conditioning, and refrigeration equipment. The receptacle outlet shall not be connected to the load side of the equipment's branch-circuit disconnecting means.

Exception: A receptacle outlet shall not be required at one- and two-family dwellings for the service of evaporative coolers.

(B) Other Electrical Equipment. In other than one- and two-family dwellings, a receptacle outlet shall be located as specified in 210.63(B)(1) and (B)(2).

(1) Indoor Service Equipment. The required receptacle outlet shall be located within the same room or area as the service equipment.

Δ (2) Indoor Equipment Requiring Dedicated Equipment Spaces. Where equipment, other than service equipment, requires dedicated equipment space as specified in 110.26(E), the required receptacle outlet shall be located within the same room or area as the electrical equipment and shall not be connected to the load side of the equipment's disconnecting means.

210.65 Meeting Rooms.

(A) General. Each meeting room of not more than 93 m² (1000 ft²) in other than dwelling units shall have outlets for nonlocking-type, 125-volt, 15- or 20-ampere receptacles. The outlets shall be installed in accordance with 210.65(B). Where a room or space is provided with movable partition(s), each room size shall be determined with the partition in the position that results in the smallest size meeting room.

Informational Note No. 1: For the purposes of this section, meeting rooms are typically designed or intended for the gathering of seated occupants for such purposes as conferences, deliberations, or similar purposes, where portable electronic equipment such as computers, projectors, or similar equipment is likely to be used.

Informational Note No. 2: Examples of rooms that are not meeting rooms include auditoriums, schoolrooms, and coffee shops.

(B) Receptacle Outlets Required. The total number of receptacle outlets, including floor outlets and receptacle outlets in fixed furniture, shall not be less than as determined in 210.65(B)(1) and (B)(2).

(1) Receptacle Outlets in Fixed Walls. The required number of receptacle outlets shall be determined in accordance with 210.52(A)(1) through (A)(4). These receptacle outlets shall be permitted to be located as determined by the installer, designer, or building owner.

Δ (2) Floor Outlets. A meeting room with any floor dimension that is 3.7 m (12 ft) or greater in any direction and that has a floor area of at least 20 m² (215 ft²) shall have at least one floor receptacle outlet, or at least one floor outlet to serve a receptacle(s), located at a distance not less than 1.8 m (6 ft) from any fixed wall for each 20 m² (215 ft²) or fraction thereof.

Informational Note No. 1: See 314.27(B) for requirements on floor boxes used for receptacles located in the floor.

Informational Note No. 2: See 518.1 for requirements on assembly occupancies designed for 100 or more persons.

210.70 Lighting Outlets Required. Lighting outlets shall be installed where specified in 210.70(A), (B), and (C). The switch or wall-mounted control device shall not rely exclusively on a battery unless a means is provided for automatically energizing the lighting outlets upon battery failure.

Δ (A) Dwelling Units. In dwelling units, lighting outlets shall be installed in accordance with 210.70(A)(1) and (A)(2).

(1) Habitable Rooms, Kitchens, Laundry Areas, and Bathrooms. At least one lighting outlet controlled by a listed wall-mounted control device shall be installed in every habitable room, kitchen, laundry area, and bathroom. The wall-mounted control device shall be located near an entrance to the room on a wall.

Exception No. 1: In other than kitchens, laundry areas, and bathrooms, one or more receptacles controlled by a listed wall-mounted control device shall be permitted in lieu of lighting outlets.

Exception No. 2: Lighting outlets shall be permitted to be controlled by occupancy sensors that are (1) in addition to listed wall-mounted control devices or (2) located at a customary wall switch location and equipped with a manual override that will allow the sensor to function as a wall switch.

Δ (2) Additional Locations. Additional lighting outlets shall be installed in accordance with the following:

- (1) At least one lighting outlet controlled by a listed wall-mounted control device shall be installed in hallways, stairways, attached garages, detached garages, and accessory buildings with electric power.
- (2) For dwelling units, attached garages, and detached garages with electric power, at least one exterior lighting outlet controlled by a listed wall-mounted control device shall be installed to provide illumination on the exterior side of outdoor entrances or exits with grade-level access. A vehicle door in a garage shall not be considered as an outdoor entrance or exit.

Exception to (2): For an outdoor, grade-level bulkhead door with stairway access to a sub-grade-level basement, the required lighting outlet that provides illumination on the stairway steps shall be permitted to be located in the basement interior within 1.5 m (5 ft) horizontally of the bottommost stairway riser. This interior lighting outlet shall be permitted to be controlled by a listed wall-mounted control device or by a unit switch of the interior luminaire or interior lampholder.

- (3) Where lighting outlets are installed for an interior stairway with six or more risers between floor levels, there

shall be a listed wall-mounted control device at each floor level and at each landing level that includes a stairway entry to control the lighting outlets.

Exception to (1), (2), and (3): Remote, central, or automatic control of lighting shall be permitted in hallways, in stairways, and at outdoor entrances.

- (4) Dimmer control of lighting outlets installed in accordance with 210.70(A)(2)(3) shall not be permitted unless the listed control devices can provide dimming control to maximum brightness at each control location for the interior stairway illumination.

(B) Guest Rooms or Guest Suites. In hotels, motels, or similar occupancies, guest rooms or guest suites shall have at least one lighting outlet controlled by a listed wall-mounted control device installed in every habitable room and bathroom.

Exception No. 1: In other than bathrooms and kitchens where provided, one or more receptacles controlled by a listed wall-mounted control device shall be permitted in lieu of lighting outlets.

Exception No. 2: Lighting outlets shall be permitted to be controlled by occupancy sensors that are (1) in addition to listed wall-mounted control devices or (2) located at a customary wall switch location and equipped with a manual override that allows the sensor to function as a wall switch.

(C) All Occupancies. For attics and underfloor spaces, utility rooms, and basements, at least one lighting outlet containing a switch or controlled by a wall switch or listed wall-mounted control device shall be installed where these spaces are used for storage or contain equipment requiring servicing. A point of control shall be at each entry that permits access to the attic and underfloor space, utility room, or basement. Where a lighting outlet is installed for equipment requiring service, the lighting outlet shall be installed at or near the equipment.

ARTICLE 215 Feeders

- Δ **215.1 Scope.** This article covers the installation requirements, overcurrent protection requirements, minimum size, and ampacity of conductors for feeders not over 1000 volts ac or 1500 volts dc, nominal.

Informational Note: See Part III of Article 235 for feeders over 1000 volts ac or 1500 volts dc.

- Δ **215.2 Minimum Rating and Size.**

- Δ **(A) General.** Feeder conductors shall have an ampacity not less than the larger of 215.2(A)(1) or (A)(2) and shall comply with 110.14(C).

- N **(1) Continuous and Noncontinuous Loads.** Where a feeder supplies continuous loads or any combination of continuous and noncontinuous loads, the minimum feeder conductor size shall have an ampacity not less than the noncontinuous load plus 125 percent of the continuous load.

Exception No. 1: If the assembly, including the overcurrent devices protecting the feeder(s), is listed for operation at 100 percent of its

rating, the ampacity of the feeder conductors shall be permitted to be not less than the sum of the continuous load plus the noncontinuous load.

Exception No. 2: Where a portion of a feeder is connected at both its supply and load ends to separately installed pressure connections as covered in 110.14(C)(2), it shall be permitted to have an ampacity not less than the sum of the continuous load plus the noncontinuous load. No portion of a feeder installed under this exception shall extend into an enclosure containing either the feeder supply or the feeder load terminations, as covered in 110.14(C)(1).

Exception No. 3: Grounded conductors that are not connected to an overcurrent device shall be permitted to be sized at 100 percent of the continuous and noncontinuous load.

- N **(2) Ampacity Adjustment or Correction Factors.** The minimum feeder conductor size shall have an ampacity not less than the maximum load to be served after the application of any adjustment or correction factors in accordance with 310.14.

Informational Note No. 1: See Informative Annex D for Examples D1 through D11.

Informational Note No. 2: Conductors for feeders, as defined in Article 100, sized to prevent a voltage drop exceeding 3 percent at the farthest outlet of power, heating, and lighting loads, or combinations of such loads, and where the maximum total voltage drop on both feeders and branch circuits to the farthest outlet does not exceed 5 percent, will provide reasonable efficiency of operation.

Informational Note No. 3: See 210.19, Informational Note for voltage drop for branch circuits.

(B) Grounded Conductor. The size of the feeder circuit grounded conductor shall not be smaller than the equipment grounding conductor size required by 250.122, except that 250.122(F) shall not apply where grounded conductors are run in parallel.

Additional minimum sizes shall be as specified in 215.2(C) under the conditions stipulated.

(C) Ampacity Relative to Service Conductors. The feeder conductor ampacity shall not be less than that of the service conductors where the feeder conductors carry the total load supplied by service conductors with an ampacity of 55 amperes or less.

- **215.3 Overcurrent Protection.** Feeders shall be protected against overcurrent in accordance with Part I of Article 240. Where a feeder supplies continuous loads or any combination of continuous and noncontinuous loads, the rating of the overcurrent device shall not be less than the noncontinuous load plus 125 percent of the continuous load.

Exception: Where the assembly, including the overcurrent devices protecting the feeder(s), is listed for operation at 100 percent of its rating, the ampere rating of the overcurrent device shall be permitted to be not less than the sum of the continuous load plus the noncontinuous load.

215.4 Feeders with Common Neutral Conductor.

(A) Feeders with Common Neutral. Up to three sets of 3-wire feeders or two sets of 4-wire or 5-wire feeders shall be permitted to utilize a common neutral.

(B) In Metal Raceway or Enclosure. Where installed in a metal raceway or other metal enclosure, all conductors of all feeders using a common neutral conductor shall be enclosed within the same raceway or other enclosure as required in 300.20.

215.5 Diagrams of Feeders. If required by the authority having jurisdiction, a diagram showing feeder details shall be provided prior to the installation of the feeders. Such a diagram shall show the area in square feet of the building or other structure supplied by each feeder, the total calculated load before applying demand factors, the demand factors used, the calculated load after applying demand factors, and the size and type of conductors to be used.

215.6 Feeder Equipment Grounding Conductor. Where a feeder supplies branch circuits in which equipment grounding conductors are required, the feeder shall include or provide an equipment grounding conductor, to which the equipment grounding conductors of the branch circuits shall be connected. Where the feeder supplies a separate building or structure, the requirements of 250.32 shall apply.

215.7 Ungrounded Conductors Tapped from Grounded Systems. Two-wire dc circuits and ac circuits of two or more ungrounded conductors shall be permitted to be tapped from the ungrounded conductors of circuits having a grounded neutral conductor. Switching devices in each tapped circuit shall have a pole in each ungrounded conductor.

215.9 Ground-Fault Circuit-Interrupter Protection for Personnel. Feeders shall be permitted to be protected by a listed ground-fault circuit interrupter installed in a readily accessible location in lieu of the provisions for such interrupters as specified in 210.8 and 590.6(A).

▲ 215.10 Ground-Fault Protection of Equipment. Each feeder disconnect rated 1000 amperes or more and installed on solidly grounded wye electrical systems of more than 150 volts to ground, but not exceeding 1000 volts phase-to-phase, shall be provided with ground-fault protection of equipment in accordance with 230.95.

Informational Note: See 517.17 for buildings that contain health care occupancies.

Exception No. 1: This section shall not apply to a disconnecting means for a continuous industrial process where a nonorderly shutdown will introduce additional or increased hazards.

Exception No. 2: This section shall not apply if ground-fault protection of equipment is provided on the supply side of the feeder and on the load side of any transformer supplying the feeder.

Exception No. 3: If temporary feeder conductors are used to connect a generator to a facility for repair, maintenance, or emergencies, ground-fault protection of equipment shall not be required. Temporary feeders without ground-fault protection shall be permitted for the time period necessary but shall not exceed 90 days.

215.11 Circuits Derived from Autotransformers. Feeders shall not be derived from autotransformers unless the system supplied has a grounded conductor that is electrically connected to a grounded conductor of the system supplying the autotransformer.

Exception No. 1: An autotransformer shall be permitted without the connection to a grounded conductor where transforming from a nominal 208 volts to a nominal 240-volt supply or similarly from 240 volts to 208 volts.

Exception No. 2: In industrial occupancies, where conditions of maintenance and supervision ensure that only qualified persons service the installation, autotransformers shall be permitted to supply nominal 600-volt loads from nominal 480-volt systems, and 480-volt loads from nominal 600-volt systems, without the connection to a similar grounded conductor.

215.12 Identification for Feeders.

(A) Grounded Conductor. The grounded conductor of a feeder, if insulated, shall be identified in accordance with 200.6.

(B) Equipment Grounding Conductor. The equipment grounding conductor shall be identified in accordance with 250.119.

(C) Identification of Ungrounded Conductors. Ungrounded conductors shall be identified in accordance with 215.12(C)(1) or (C)(2), as applicable.

(1) Feeders Supplied from More Than One Nominal Voltage System. Where the premises wiring system has feeders supplied from more than one nominal voltage system, each ungrounded conductor of a feeder shall be identified by phase or line and system at all termination, connection, and splice points in compliance with 215.12(C)(1)(a) and (C)(1)(b).

(a) *Means of Identification.* The means of identification shall be permitted to be by separate color coding, marking tape, tagging, or other approved means.

(b) *Posting of Identification Means.* The method utilized for conductors originating within each feeder panelboard or similar feeder distribution equipment shall be documented in a manner that is readily available or shall be permanently posted at each feeder panelboard or similar feeder distribution equipment.

(2) Feeders Supplied from Direct-Current Systems. Where a feeder is supplied from a dc system operating at more than 60 volts, each ungrounded conductor of 4 AWG or larger shall be identified by polarity at all termination, connection, and splice points by marking tape, tagging, or other approved means; each ungrounded conductor of 6 AWG or smaller shall be identified by polarity at all termination, connection, and splice points in compliance with 215.12(C)(2)(a) and (C)(2)(b). The identification methods utilized for conductors originating within each feeder panelboard or similar feeder distribution equipment shall be documented in a manner that is readily available or shall be permanently posted at each feeder panelboard or similar feeder distribution equipment.

(a) *Positive Polarity, Sizes 6 AWG or Smaller.* Where the positive polarity of a dc system does not serve as the connection for the grounded conductor, each positive ungrounded conductor shall be identified by one of the following means:

- (1) A continuous red outer finish
- (2) A continuous red stripe durably marked along the conductor's entire length on insulation of a color other than green, white, gray, or black
- (3) Imprinted plus signs (+) or the word POSITIVE or POS durably marked on insulation of a color other than green, white, gray, or black, and repeated at intervals not exceeding 610 mm (24 in.) in accordance with 310.8(B)
- (4) An approved permanent marking means such as sleeving or shrink-tubing that is suitable for the conductor size, at all termination, connection, and splice points, with imprinted plus signs (+) or the word POSITIVE or POS

durably marked on insulation of a color other than green, white, gray, or black

(b) *Negative Polarity, Sizes 6 AWG or Smaller.* Where the negative polarity of a dc system does not serve as the connection for the grounded conductor, each negative ungrounded conductor shall be identified by one of the following means:

- (1) A continuous black outer finish
- (2) A continuous black stripe durably marked along the conductor's entire length on insulation of a color other than green, white, gray, or red
- (3) Imprinted minus signs (–) or the word NEGATIVE or NEG durably marked on insulation of a color other than green, white, gray, or red, and repeated at intervals not exceeding 610 mm (24 in.) in accordance with 310.8(B)
- (4) An approved permanent marking means such as sleeving or shrink-tubing that is suitable for the conductor size, at all termination, connection, and splice points, with imprinted minus signs (–) or the word NEGATIVE or NEG durably marked on insulation of a color other than green, white, gray, or red

215.15 Barriers. Barriers shall be placed such that no energized, uninsulated, ungrounded busbar or terminal is exposed to inadvertent contact by persons or maintenance equipment while servicing load terminations in panelboards, switchboards, switchgear, or motor control centers supplied by feeder taps in 240.21(B) or transformer secondary conductors in 240.21(C) when the disconnecting device, to which the tap conductors are terminated, is in the open position.

215.18 Surge Protection.

(A) Surge-Protective Device. Where a feeder supplies any of the following, a surge-protective device (SPD) shall be installed:

- (1) Dwelling units
- (2) Dormitory units
- (3) Guest rooms and guest suites of hotels and motels
- (4) Areas of nursing homes and limited-care facilities used exclusively as patient sleeping rooms

(B) Location. The SPD shall be installed in or adjacent to distribution equipment, connected to the load side of the feeder, that contains branch circuit overcurrent protective device(s) that supply the locations specified in 215.18(A).

Informational Note: Surge protection is most effective when closest to the branch circuit. Surges can be generated from multiple sources including, but not limited to, lightning, the electric utility, or utilization equipment.

(C) Type. The SPD shall be a Type 1 or Type 2 SPD.

(D) Replacement. Where the distribution equipment supplied by the feeder is replaced, all of the requirements of this section shall apply.

(E) Ratings. SPDs shall have a nominal discharge current rating (In) of not less than 10kA.

ARTICLE 220

Branch-Circuit, Feeder, and Service Load Calculations

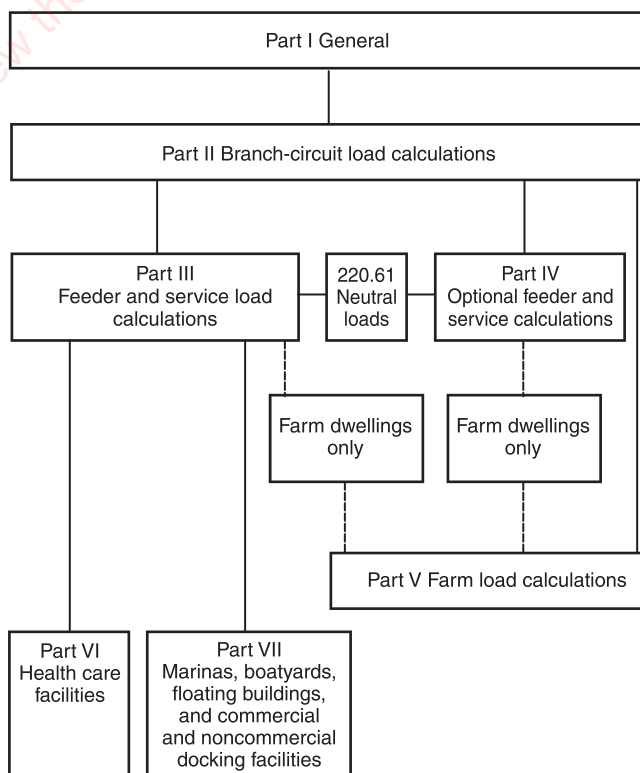
Part I. General

220.1 Scope. This article provides requirements for calculating branch-circuit, feeder, and service loads. Part I provides general requirements for calculation methods. Part II provides calculation methods for branch-circuit loads. Part III and Part IV provide calculation methods for feeder and service loads. Part V provides calculation methods for farm loads. Part VI provides calculation methods for health care facilities. Part VII provides calculation methods for marinas, boatyards, floating buildings, and commercial and noncommercial docking facilities.

Informational Note No. 1: See Informative Annex D for examples.

Informational Note No. 2: See Informational Note Figure 220.1 for information on the organization of this article.

220.3 Other Articles for Specific-Purpose Calculations. Table 220.3 shall provide references for specific-purpose calculation requirements not located in Chapters 5, 6, or 7 that amend or supplement the requirements of this article.



Informational Note Figure 220.1 Branch-Circuit, Feeder, and Service Load Calculation Methods.

220.5 Calculations.

(A) Voltages. Unless other voltages are specified, for purposes of calculating branch-circuit and feeder loads, nominal system voltages of 120, 120/240, 208Y/120, 240, 347, 480Y/277, 480, 600Y/347, and 600 volts shall be used.

(B) Fractions of an Ampere. Calculations shall be permitted to be rounded to the nearest whole ampere, with decimal fractions smaller than 0.5 dropped.

(C) Floor Area. The floor area for each floor shall be calculated from the outside dimensions of the building, dwelling unit, or other area involved. For dwelling units, the calculated floor area shall not include open porches or unfinished areas not adaptable for future use as a habitable room or occupiable space.

Part II. Branch-Circuit Load Calculations

220.10 General. Branch-circuit loads shall be calculated in accordance with the following sections:

- (1) 220.14 for other loads — all occupancies
- (2) 220.16 for additions to existing installations
- (3) 220.41 for dwelling units
- (4) 220.42 for lighting loads for non-dwelling occupancies
- (5) 220.44 for hotel and motel occupancies

220.11 Maximum Load. The total load on a branch circuit shall not exceed the rating of the branch circuit nor the maximum loads specified in 220.11(A) through (C) under the conditions specified therein.

(A) Motor-Operated and Combination Loads. Where a circuit supplies only motor-operated loads, the conductor sizing requirement specified in 430.22 shall apply. Where a circuit supplies only air-conditioning equipment, refrigerating equip-

ment, or both, the requirements of 440.6 shall apply. For circuits supplying loads consisting of motor-operated utilization equipment that is fastened in place and has a motor larger than $\frac{1}{8}$ hp in combination with other loads, the total calculated load shall be based on 125 percent of the largest motor load plus the sum of the other loads in accordance with 430.24.

(B) Inductive and LED Lighting Loads. For circuits supplying lighting units that have ballasts, transformers, autotransformers, or LED drivers, the calculated load shall be based on the total ampere ratings of such units and not on the total watts of the lamps.

(C) Electric Cooking Appliances. Applying demand factors for ranges, wall-mounted ovens, counter-mounted cooking units, and other household cooking appliance loads in excess of 1 $\frac{1}{4}$ kW shall be permitted in accordance with Table 220.55, including Notes 4, 5, and 6.

220.14 Other Loads — All Occupancies. Branch-circuit load calculations shall include calculation of a minimum load on each outlet as calculated in 220.14(A) through (K) and then summed to establish the load on the branch circuit.

In all occupancies, the minimum load for each outlet for general-use receptacles and outlets not used for general illumination shall not be less than that calculated in 220.14(A) through (K), with the loads shown being based on nominal branch-circuit voltages.

Exception: The loads of outlets serving switchboards and switching frames in telephone exchanges shall be waived from the calculations.

(A) Specific Appliances or Loads. An outlet for a specific appliance or other load not covered in 220.14(B) through (K) shall be calculated based on the ampere rating of the appliance or load served.

(B) Electric Dryers and Electric Cooking Appliances in Dwellings and Household Cooking Appliances Used in Instructional Programs. Load calculations shall be permitted as specified in 220.54 for electric dryers and in 220.55 for electric ranges and other cooking appliances.

(C) Motor Outlets. The conductor sizing requirements specified in 430.22, 430.24, and 440.6 shall be used to determine the loads for motor outlets.

(D) Luminaires. An outlet supplying a luminaire(s) shall be calculated based on the maximum volt-ampere rating of the equipment and lamps for which the luminaire(s) is rated.

(E) Heavy-Duty Lampholders. Outlets for heavy-duty lampholders shall be calculated at a minimum of 600 volt-amperes.

(F) Sign and Outline Lighting. Sign and outline lighting outlets shall be calculated at a minimum of 1200 volt-amperes for each required branch circuit specified in 600.5(A).

(G) Show Windows. Show windows shall be calculated in accordance with either of the following:

- (1) The unit load per outlet as required in other provisions of this section
- (2) At 200 volt-amperes per linear 300 mm (1 ft) of show window

(H) Fixed Multioutlet Assemblies. Fixed multioutlet assemblies used in other than dwelling units or the guest rooms or

Table 220.3 Specific-Purpose Calculation References

Calculation	Article	Section (or Part)
Air-conditioning and refrigerating equipment, branch-circuit conductor sizing	440	Part IV
Capacitors	460	460.8
Fixed electric heating equipment for pipelines and vessels, branch-circuit sizing	427	427.4
Fixed electric space-heating equipment, branch-circuit sizing	424	424.3
Fixed outdoor electric deicing and snow-melting equipment, branch-circuit sizing	426	426.4
Fixed resistance and electrode industrial process heating equipment	425	425.4
Motors, feeder demand factor	430	430.26
Motors, multimotor and combination-load equipment	430	430.25
Motors, several motors or a motor(s) and other load(s)	430	430.24
Over 1000-volt ac and 1500-volt dc branch-circuit calculations	235	235.19
Over 1000-volt feeder calculations	215	215.2(B)
Phase converters, conductors	455	455.6
Storage-type water heaters	422	422.11

guest suites of hotels or motels shall be calculated in accordance with the following:

- (1) Where appliances are unlikely to be used simultaneously, each 1.5 m (5 ft) or fraction thereof of each separate and continuous length shall be considered as one outlet of not less than 180 volt-amperes.
- (2) Where appliances are likely to be used simultaneously, each 300 mm (1 ft) or fraction thereof shall be considered as an outlet of not less than 180 volt-amperes.

For the purposes of this section, the calculation shall be permitted to be based on the portion that contains receptacles.

Δ (I) Receptacle Outlets. Except as covered in 220.41 and 220.14(J), receptacle outlets shall be calculated at not less than 180 volt-amperes for each single or for each multiple receptacle on one yoke. A single piece of equipment consisting of a multiple receptacle comprised of four or more receptacles shall be calculated at not less than 90 volt-amperes per receptacle. This provision shall not be applicable to the receptacle outlets specified in 210.11(C)(1) and (C)(2).

N (J) Receptacle Outlets in Office Buildings. In office buildings, the receptacle loads shall be calculated to be the larger of the following:

- (1) The calculated load from 220.14(I)
- (2) 11 volt-amperes/m² (1 volt-ampere/ft²)

(K) Other Outlets. Other outlets not covered in 220.14(A) through (J) shall be calculated based on 180 volt-amperes per outlet.

220.16 Loads for Additions to Existing Installations.

(A) Dwelling Units. Loads added to an existing dwelling unit(s) shall comply with the following as applicable:

- (1) Loads for structural additions to an existing dwelling unit or for a previously unwired portion of an existing dwelling unit shall be calculated in accordance with 220.14.
- (2) Loads for new circuits or extended circuits in previously wired dwelling units shall be calculated in accordance with 220.14.

(B) Other Than Dwelling Units. Loads for new circuits or extended circuits in other than dwelling units shall be calculated in accordance with either 220.42 or 220.14, as applicable.

Part III. Feeder and Service Load Calculations

Δ 220.40 General. The calculated load of a feeder or service shall not be less than the sum of the loads on the branch circuits supplied, as determined by Part II of this article, after any applicable demand factors permitted or required by Part III, IV, V, VI, or VII have been applied.

Informational Note No. 1: See Informative Annex D, Examples D1(a) through D10, for examples of feeder and service load calculations.

Informational Note No. 2: See 220.11(B) for the maximum load in amperes permitted for lighting units operating at less than 100 percent power factor.

Δ 220.41 Dwelling Units, Minimum Unit Load. In one-family, two-family, and multifamily dwellings, the minimum unit load shall be not less than 33 volt-amperes/m² (3 volt-amperes/ft²).

Unit loads include the following lighting and receptacle outlets, and no additional load calculations shall be required:

- (1) All general-use receptacle outlets of 20-ampere rating or less, including receptacles connected to the circuits specified in 210.11(C)(3) and (C)(4)
- (2) The receptacle outlets specified in 210.52(E) and (G)
- (3) The lighting outlets specified in 210.70

The minimum lighting load shall be determined using the minimum unit load and the floor area as determined in 220.5(C) for dwelling occupancies. Motors rated less than 1/8 hp and connected to a lighting circuit shall be considered part of the minimum lighting load.

220.42 Lighting Load for Non-Dwelling Occupancies.

(A) General. A unit load of not less than that specified in Table 220.42(A) for non-dwelling occupancies and the floor area determined in 220.5(C) shall be used to calculate the minimum lighting load. Motors rated less than 1/8 HP and connected to a lighting circuit shall be considered general lighting load.

Informational Note: The unit values of Table 220.42(A) are based on minimum load conditions and 80 percent power factor and might not provide sufficient capacity for the installation contemplated.

(B) Energy Code. Where the building is designed and constructed to comply with an energy code adopted by the local authority, the lighting load shall be permitted to be calculated using the unit values specified in the energy code where the following conditions are met:

- (1) A power monitoring system is installed that will provide continuous information regarding the total general lighting load of the building.
- (2) The power monitoring system will be set with alarm values to alert the building owner or manager if the lighting load exceeds the values set by the energy code. Automatic means to take action to reduce the connected load shall be permitted.
- (3) The demand factors specified in 220.45 are not applied to the general lighting load.
- (4) The continuous load multiplier of 125 percent shall be applied.

Δ 220.43 Office Buildings. In office buildings, the receptacle loads shall be calculated to be the larger of the following:

- (1) The calculated load from 220.14(I) after Table 220.47 demand factors have been applied
- (2) 11 volt-amperes/m² or 1 volt-ampere/ft²

Δ 220.44 Hotel and Motel Occupancies. In guest rooms or guest suites of hotels and motels, the following lighting and receptacle outlets are included in the minimum unit load in Table 220.42(A), and no additional load calculations shall be required for such outlets:

- (1) All general-use receptacle outlets of 20-ampere rating or less, including receptacles connected to the circuits in 210.11(C)(3) and (C)(4)
- (2) The receptacle outlets specified in 210.52(E)(3)
- (3) The lighting outlets specified in 210.70

Table 220.42(A) General Lighting Loads by Non-Dwelling Occupancy

Type of Occupancy	Unit Load	
	Volt-amperes/ m ²	Volt-amperes/ ft ²
Automotive facility	16	1.5
Convention center	15	1.4
Courthouse	15	1.4
Dormitory	16	1.5
Exercise center	15	1.4
Fire station	14	1.3
Gymnasium ¹	18	1.7
Health care clinic	17	1.6
Hospital	17	1.6
Hotel or motel, or apartment house without provisions for cooking by tenants ²	18	1.7
Library	16	1.5
Manufacturing facility ³	24	2.2
Motion picture theater	17	1.6
Museum	17	1.6
Office ⁴	14	1.3
Parking garage ⁵	3	0.3
Penitentiary	13	1.2
Performing arts theater	16	1.5
Police station	14	1.3
Post office	17	1.6
Religious facility	24	2.2
Restaurant ⁶	16	1.5
Retail ^{7, 8}	20	1.9
School/university	16	1.5
Sports arena	16	1.5
Town hall	15	1.4
Transportation	13	1.2
Warehouse	13	1.2
Workshop	18	1.7

Note: The 125 percent multiplier for a continuous load as specified in 210.20(A) is included, therefore no additional multiplier shall be required when using the unit loads in this table for calculating the minimum lighting load for a specified occupancy.

¹Armories and auditoriums are considered gymnasium-type occupancies.

²Lodge rooms are similar to hotels and motels.

³Industrial commercial loft buildings are considered manufacturing-type occupancies.

⁴Banks are office-type occupancies.

⁵Commercial (storage) garages are considered parking garage occupancies.

⁶Clubs are considered restaurant occupancies.

⁷Barber shops and beauty parlors are considered retail occupancies.

⁸Stores are considered retail occupancies.

220.45 General Lighting. The demand factors specified in Table 220.45 shall apply to that portion of the total branch-circuit load calculated for general illumination. They shall not be applied in determining the number of branch circuits for general illumination.

220.46 Show-Window and Track Lighting.

(A) Show Windows. For show-window lighting, a load of not less than 660 volt-amperes/linear meter or 200 volt-amperes/

Table 220.45 Lighting Load Demand Factors

Type of Occupancy	Portion of Lighting Load to Which Demand Factor Applies (Volt-Amperes)	Demand Factor (%)
Dwelling units	First 3000 at	100
	From 3001 to 120,000 at	35
	Remainder over 120,000 at	25
Hotels and motels, including apartment houses without provision for cooking by tenants*	First 20,000 or less at	60
	From 20,001 to 100,000 at	50
	Remainder over 100,000 at	35
Warehouses (storage)	First 12,500 or less at	100
	Remainder over 12,500 at	50
All others	Total volt-amperes	100

*The demand factors of this table shall not apply to the calculated load of feeders or services supplying areas in hotels and motels where the entire lighting is likely to be used at one time, as in ballrooms or dining rooms.

linear foot shall be included for a show window, measured horizontally along its base.

Informational Note: See 220.14(G) for branch circuits supplying show windows.

(B) Track Lighting. For track lighting in other than dwelling units or guest rooms or guest suites of hotels or motels, an additional load of 150 volt-amperes shall be included for every 600 mm (2 ft) of lighting track or fraction thereof. Where multicircuit track is installed, the load shall be considered to be divided equally between the track circuits.

Exception: If the track lighting is supplied through a device that limits the current to the track, the load shall be permitted to be calculated based on the rating of the device used to limit the current.

220.47 Receptacle Loads — Other Than Dwelling Units. Receptacle loads calculated in accordance with 220.14(H) and (I) shall be permitted to be made subject to the demand factors given in Table 220.45 or Table 220.47.

220.50 Motors and Air-Conditioning Equipment.

(A) Motors. The conductor sizing requirements specified in 430.24 and 430.25 and the feeder demand factor calculation method specified in 430.26 shall be used to determine motor loads.

(B) Air-Conditioning Equipment. The conductor sizing requirements specified in Part IV of Article 440 shall be used to determine air-conditioning loads for hermetic refrigerant motor-compressors.

Table 220.47 Demand Factors for Non-Dwelling Receptacle Loads

Portion of Receptacle Load to Which Demand Factor Applies (Volt-Amperes)	Demand Factor (%)
First 10 kVA or less at	100
Remainder over 10 kVA at	50

220.51 Fixed Electric Space Heating. Fixed electric space-heating loads shall be calculated at 100 percent of the total connected load. However, in no case shall a feeder or service load current rating be less than the rating of the largest branch circuit supplied.

Exception: If reduced loading of the conductors results from units operating on duty-cycle or intermittently, or from all units not operating at the same time, the authority having jurisdiction shall be permitted to grant permission for feeder and service conductors to have an ampacity less than 100 percent if the conductors have an ampacity for the load so determined.

220.52 Small-Appliance and Laundry Loads — Dwelling Unit.

(A) Small-Appliance Circuit Load. In each dwelling unit, the load shall be calculated at 1500 volt-amperes for each 2-wire small-appliance branch circuit as covered by 210.11(C)(1). Where the load is subdivided through two or more feeders, the calculated load for each shall include not less than 1500 volt-amperes for each 2-wire small-appliance branch circuit. These loads shall be permitted to be included with the general lighting load and subjected to the demand factors provided in Table 220.45.

Exception: The individual branch circuit permitted by 210.52(B)(1), Exception No. 2, shall be permitted to be excluded from the calculation required by 220.52.

(B) Laundry Circuit Load. A load of not less than 1500 volt-amperes shall be included for each 2-wire laundry branch circuit installed as covered by 210.11(C)(2). This load shall be permitted to be included with the general lighting load and shall be subjected to the demand factors provided in Table 220.45.

220.53 Appliance Load — Dwelling Unit(s). Applying a demand factor of 75 percent to the nameplate rating load of four or more appliances rated $\frac{1}{4}$ hp or greater, or 500 watts or greater, that are fastened in place, and that are served by the same feeder or service in a one-family, two-family, or multifamily dwelling shall be permitted. This demand factor shall not apply to the following:

- (1) Household electric cooking equipment that is fastened in place
- (2) Clothes dryers
- (3) Space heating equipment
- (4) Air-conditioning equipment
- (5) Electric vehicle supply equipment (EVSE)

220.54 Electric Clothes Dryers — Dwelling Unit(s). The load for household electric clothes dryers in a dwelling unit(s) shall be either 5000 watts (volt-amperes) or the nameplate rating, whichever is larger, for each dryer served. The use of the demand factors in Table 220.54 shall be permitted. Where two or more single-phase dryers are supplied by a 3-phase, 4-wire feeder or service, the total load shall be calculated on the basis of twice the maximum number connected between any two phases. Kilovolt-amperes (kVA) shall be considered equivalent to kilowatts (kW) for loads calculated in this section.

Δ 220.55 Electric Cooking Appliances in Dwelling Units and Household Cooking Appliances Used in Instructional Programs. The load for household electric ranges, wall-mounted ovens, counter-mounted cooking units, and other household cooking appliances individually rated in excess of $1\frac{3}{4}$ kW shall be permitted to be calculated in accordance with

Table 220.54 Demand Factors for Household Electric Clothes Dryers

Number of Dryers	Demand Factor (%)
1–4	100
5	85
6	75
7	65
8	60
9	55
10	50
11	47
12–23	47% minus 1% for each dryer exceeding 11
24–42	35% minus 0.5% for each dryer exceeding 23
43 and over	25%

Table 220.55. Kilovolt-amperes (kVA) shall be considered equivalent to kilowatts (kW) for loads calculated under this section.

Where two or more single-phase ranges are supplied by a 3-phase, 4-wire feeder or service, the total load shall be calculated on the basis of twice the maximum number connected between any two phases.

Informational Note No. 1: See Informative Annex D for examples.

Informational Note No. 2: See Table 220.56 for demand factors for commercial cooking equipment.

220.56 Kitchen Equipment — Other Than Dwelling Unit(s). Calculating the load for commercial electric cooking equipment, dishwasher booster heaters, water heaters, and other kitchen equipment in accordance with Table 220.56 shall be permitted. Other kitchen equipment shall include equipment that is fastened in place and rated $\frac{1}{4}$ hp or greater, or 500 watts or greater. These demand factors shall be applied to all equipment that has either thermostatic control or intermittent use as kitchen equipment. These demand factors shall not apply to space-heating, ventilating, or air-conditioning equipment.

However, in no case shall the feeder or service calculated load be less than the sum of the largest two kitchen equipment loads.

N 220.57 Electric Vehicle Supply Equipment (EVSE) Load. The EVSE load shall be calculated at either 7200 watts (volt-amperes) or the nameplate rating of the equipment, whichever is larger.

Δ 220.60 Noncoincident Loads. If it is unlikely that two or more noncoincident loads will be in use simultaneously, using only the largest load(s) that will be used at one time for calculating the total load of a feeder or service shall be permitted. If a motor or air-conditioning load is part of the noncoincident load and is not the largest of the noncoincident loads, 125 percent of either the motor load or air-conditioning load, whichever is larger, shall be used in the calculation.

Table 220.55 Demand Factors and Loads for Household Electric Ranges, Wall-Mounted Ovens, Counter-Mounted Cooking Units, and Other Household Cooking Appliances over 1¼ kW Rating (Column C to be used in all cases except as otherwise permitted in Note 3.)

Number of Appliances	Demand Factor (%) (See Notes)		Column C Maximum Demand (kW) (See Notes) (Not over 12 kW Rating)
	Column A (Less than 3½ kW Rating)	Column B (3½ kW through 8¾ kW Rating)	
1	80	80	8
2	75	65	11
3	70	55	14
4	66	50	17
5	62	45	20
6	59	43	21
7	56	40	22
8	53	36	23
9	51	35	24
10	49	34	25
11	47	32	26
12	45	32	27
13	43	32	28
14	41	32	29
15	40	32	30
16	39	28	31
17	38	28	32
18	37	28	33
19	36	28	34
20	35	28	35
21	34	26	36
22	33	26	37
23	32	26	38
24	31	26	39
25	30	26	40
26–30	30	24	15 kW + 1 kW for each range
31–40	30	22	
41–50	30	20	25 kW + ¾ kW for each range
51–60	30	18	
61 and over	30	16	

Notes:

1. *Over 12 kW through 27 kW ranges all of same rating.* For ranges individually rated more than 12 kW but not more than 27 kW, the maximum demand in Column C shall be increased 5 percent for each additional kilowatt of rating or major fraction thereof by which the rating of individual ranges exceeds 12 kW.
2. *Over 8¾ kW through 27 kW ranges of unequal ratings.* For ranges individually rated more than 8¾ kW and of different ratings, but none exceeding 27 kW, an average value of rating shall be calculated by adding together the ratings of all ranges to obtain the total connected load (using 12 kW for any range rated less than 12 kW) and dividing by the total number of ranges. Then the maximum demand in Column C shall be increased 5 percent for each kilowatt or major fraction thereof by which this average value exceeds 12 kW.
3. *Over 1¼ kW through 8¾ kW.* In lieu of the method provided in Column C, adding the nameplate ratings of all household cooking appliances rated more than 1¼ kW but not more than 8¾ kW and multiplying the sum by the demand factors specified in Column A or Column B for the given number of appliances shall be permitted. Where the rating of cooking appliances falls under both Column A and Column B, the demand factors for each column shall be applied to the appliances for that column, and the results added together.
4. Calculating the branch-circuit load for one range in accordance with Table 220.55 shall be permitted.
5. The branch-circuit load for one wall-mounted oven or one counter-mounted cooking unit shall be the nameplate rating of the appliance.
6. The branch-circuit load for a counter-mounted cooking unit and not more than two wall-mounted ovens, all supplied from a single branch circuit and located in the same room, shall be calculated by adding the nameplate rating of the individual appliances and treating this total as equivalent to one range.
7. This table shall also apply to household cooking appliances rated over 1¼ kW and used in instructional programs.

Table 220.56 Demand Factors for Kitchen Equipment — Other Than Dwelling Unit(s)

Number of Units of Equipment	Demand Factor (%)
1	100
2	100
3	90
4	80
5	70
6 and over	65

220.61 Feeder or Service Neutral Load.

(A) Basic Calculation. The feeder or service neutral load shall be the maximum unbalance of the load determined by this article. The maximum unbalanced load shall be the maximum net calculated load between the neutral conductor and any one ungrounded conductor.

Exception: For 3-wire, 2-phase or 5-wire, 2-phase systems, the maximum unbalanced load shall be the maximum net calculated load between the neutral conductor and any one ungrounded conductor multiplied by 140 percent.

Δ (B) Permitted Reductions. A service or feeder supplying the following loads shall be permitted to have an additional demand factor of 70 percent applied to the amount in 220.61(B)(1) and a portion of the amount in 220.61(B)(2).

N (1) Household Electric Ranges, Wall-Mounted Ovens, Counter-Mounted Cooking Units, and Dryers. A feeder or service supplying household electric ranges, wall-mounted ovens, counter-mounted cooking units, and electric dryers, where the maximum unbalanced load has been determined in accordance with Table 220.55 for ranges and Table 220.54 for dryers.

N (2) Unbalanced Load in Excess of 200 Amperes. That portion of the unbalanced load in excess of 200 amperes where the feeder or service is supplied from a 3-wire dc or single-phase ac system; a 4-wire, 3-phase system; a 3-wire, 2-phase system; or a 5-wire, 2-phase system.

Informational Note: See Informative Annex D, Examples D1(a), D1(b), D2(b), D4(a), and D5(a) for examples of unbalanced feeder or service neutral loads.

(C) Prohibited Reductions. There shall be no reduction of the neutral or grounded conductor capacity applied to the amount in 220.61(C)(1), or portion of the amount in (C)(2), from that determined by the basic calculation:

- (1) Any portion of a 3-wire circuit consisting of 2 ungrounded conductors and the neutral conductor of a 4-wire, 3-phase, wye-connected system
- (2) That portion consisting of nonlinear loads supplied from a 4-wire, wye-connected, 3-phase system

Informational Note: A 3-phase, 4-wire, wye-connected power system used to supply power to nonlinear loads might necessitate that the power system design allows for the possibility of high harmonic neutral conductor currents.

N 220.70 Energy Management Systems (EMSs). If an energy management system (EMS) is used to limit the current to a feeder or service in accordance with 750.30, a single value equal to the maximum ampere setpoint of the EMS shall be

permitted to be used in load calculations for the feeder or service.

The setpoint value of the EMS shall be considered a continuous load for the purposes of load calculations.

Part IV. Optional Feeder and Service Load Calculations

220.80 General. Optional feeder and service load calculations shall be permitted in accordance with Part IV.

220.82 Dwelling Unit.

(A) Feeder and Service Load. This section applies to a dwelling unit having the total connected load served by a single 120/240-volt or 208Y/120-volt set of 3-wire service or feeder conductors with an ampacity of 100 or greater. It shall be permissible to calculate the feeder and service loads in accordance with this section instead of the method specified in Part III of this article. The calculated load shall be the result of adding the loads from 220.82(B) and (C). Feeder and service-entrance conductors whose calculated load is determined by this optional calculation shall be permitted to have the neutral load determined by 220.61.

(B) General Loads. The general calculated load shall be not less than 100 percent of the first 10 kVA plus 40 percent of the remainder of the following loads:

- (1) 33 volt-amperes/m² or 3 volt-amperes/ft² for general lighting and general-use receptacles. The floor area for each floor shall be calculated from the outside dimensions of the dwelling unit. The calculated floor area shall not include open porches, garages, or unused or unfinished spaces not adaptable for future use.
- (2) 1500 volt-amperes for each 2-wire, 20-ampere small-appliance branch circuit and each laundry branch circuit covered in 210.11(C)(1) and (C)(2).
- (3) The nameplate rating of the following:
 - a. All appliances that are fastened in place, permanently connected, or located to be on a specific circuit
 - b. Ranges, wall-mounted ovens, counter-mounted cooking units
 - c. Clothes dryers that are not connected to the laundry branch circuit specified in 220.82(B)(2)
 - d. Water heaters
- (4) The nameplate ampere or kVA rating of all permanently connected motors not included in 220.82(B)(3).

(C) Heating and Air-Conditioning Load. The largest of the following six selections (load in kVA) shall be included:

- (1) 100 percent of the nameplate rating(s) of the air conditioning and cooling.
- (2) 100 percent of the nameplate rating(s) of the heat pump when the heat pump is used without any supplemental electric heating.
- (3) 100 percent of the nameplate rating(s) of the heat pump compressor and 65 percent of the supplemental electric heating for central electric space-heating systems. If the heat pump compressor is prevented from operating at the same time as the supplementary heat, it does not need to be added to the supplementary heat for the total central space heating load.
- (4) 65 percent of the nameplate rating(s) of electric space heating if less than four separately controlled units.

- (5) 40 percent of the nameplate rating(s) of electric space heating if four or more separately controlled units.
- (6) 100 percent of the nameplate ratings of electric thermal storage and other heating systems where the usual load is expected to be continuous at the full nameplate value. Systems qualifying under this selection shall not be calculated under any other selection in 220.82(C).

220.83 Existing Dwelling Unit. This section shall be permitted to be used to determine if the existing service or feeder is of sufficient capacity to serve additional loads. Where the dwelling unit is served by a 120/240-volt or 208Y/120-volt, 3-wire service or feeder, calculating the total load in accordance with 220.83(A) or (B) shall be permitted.

Δ (A) Where Additional Air-Conditioning Equipment or Electric Space-Heating Equipment Is Not to Be Installed. The percentages listed in Table 220.83(A) shall be used for existing and additional new loads.

Load calculations shall include the following:

- (1) General lighting and general-use receptacles at 33 volt-amperes/m² or 3 volt-amperes/ft² as determined by 220.42
- (2) 1500 volt-amperes for each 2-wire, 20-ampere small-appliance branch circuit and each laundry branch circuit covered in 210.11(C)(1) and (C)(2)
- (3) The nameplate rating of the following:
 - a. All appliances that are fastened in place, permanently connected, or located to be on a specific circuit
 - b. Ranges, wall-mounted ovens, counter-mounted cooking units
 - c. Clothes dryers that are not connected to the laundry branch circuit specified in item (2)
 - d. Water heaters

Δ (B) Where Additional Air-Conditioning Equipment or Electric Space-Heating Equipment Is to Be Installed. The percentages listed in Table 220.83(B) shall be used for existing and additional new loads. The larger connected load of air conditioning or space heating, but not both, shall be used.

Other loads shall include the following:

- (1) General lighting and general-use receptacles at 33 volt-amperes/m² or 3 volt-amperes/ft² as determined by 220.42
- (2) 1500 volt-amperes for each 2-wire, 20-ampere small-appliance branch circuit and each laundry branch circuit covered in 210.11(C)(1) and (C)(2)
- (3) The nameplate rating of the following:
 - a. All appliances that are fastened in place, permanently connected, or located to be on a specific circuit
 - b. Ranges, wall-mounted ovens, counter-mounted cooking units
 - c. Clothes dryers that are not connected to the laundry branch circuit specified in item (2)
 - d. Water heaters

Table 220.83(A) Without Additional Air-Conditioning or Electric Space-Heating Equipment

Load (kVA)	Percent of Load
First 8 kVA of load at	100
Remainder of load at	40

220.84 Multifamily Dwelling.

(A) Feeder or Service Load. It shall be permissible to calculate the load of a feeder or service that supplies three or more dwelling units of a multifamily dwelling in accordance with Table 220.84(B) instead of Part III of this article if all the following conditions are met:

- (1) No dwelling unit is supplied by more than one feeder.
- (2) Each dwelling unit is equipped with electric cooking equipment.

Exception: When the calculated load for multifamily dwellings without electric cooking in Part III of this article exceeds that calculated under Part IV for the identical load plus electric cooking (based on 8 kW per unit), the lesser of the two loads shall be permitted to be used.

- (3) Each dwelling unit is equipped with either electric space heating or air conditioning, or both. Feeders and service conductors whose calculated load is determined by this optional calculation shall be permitted to have the neutral load determined by 220.61.

(B) House Loads. House loads shall be calculated in accordance with Part III of this article and shall be in addition to the dwelling unit loads calculated in accordance with Table 220.84(B).

(C) Calculated Loads. The calculated load to which the demand factors of Table 220.84(B) apply shall include the following:

- (1) 33 volt-amperes/m² or 3 volt-amperes/ft² for general lighting and general-use receptacles
- (2) 1500 volt-amperes for each 2-wire, 20-ampere small-appliance branch circuit and each laundry branch circuit covered in 210.11(C)(1) and (C)(2)
- (3) The nameplate rating of the following:
 - a. All appliances that are fastened in place, permanently connected, or located to be on a specific circuit
 - b. Ranges, wall-mounted ovens, counter-mounted cooking units
 - c. Clothes dryers that are not connected to the laundry branch circuit specified in item (2)
 - d. Water heaters
- (4) The nameplate ampere or kVA rating of all permanently connected motors not included in item (3)
- (5) The larger of the air-conditioning load or the fixed electric space-heating load

220.85 Two Dwelling Units. Where two dwelling units are supplied by a single feeder or service and the calculated load under Part III of this article exceeds that for three identical units calculated under 220.84, the lesser of the two loads shall be permitted to be used.

Table 220.83(B) With Additional Air-Conditioning or Electric Space-Heating Equipment

Load	Percent of Load
Air-conditioning equipment	100
Central electric space heating	100
Less than four separately controlled space-heating units	100
First 8 kVA of all other loads	100
Remainder of all other loads	40

Table 220.84(B) Optional Calculations — Demand Factors for Three or More Multifamily Dwelling Units

Number of Dwelling Units	Demand Factor (%)
3–5	45
6–7	44
8–10	43
11	42
12–13	41
14–15	40
16–17	39
18–20	38
21	37
22–23	36
24–25	35
26–27	34
28–30	33
31	32
32–33	31
34–36	30
37–38	29
39–42	28
43–45	27
46–50	26
51–55	25
56–61	24
62 and over	23

220.86 Schools. The calculation of a feeder or service load for schools shall be permitted in accordance with Table 220.86 in lieu of Part III of this article where equipped with electric space heating, air conditioning, or both. The connected load to which the demand factors of Table 220.86 apply shall include all of the interior and exterior lighting, power, water heating, cooking, other loads, and the larger of the air-conditioning load or space-heating load within the building or structure.

Feeders and service conductors whose calculated load is determined by this optional calculation shall be permitted to have the neutral load determined by 220.61. Where the building or structure load is calculated by this optional method, feeders within the building or structure shall have ampacity as permitted in Part III of this article; however, the ampacity of an individual feeder shall not be required to be larger than the ampacity for the entire building.

This section shall not apply to portable classroom buildings.

N Table 220.86 Optional Method — Demand Factors for Feeders and Service Conductors for Schools

Connected Load		Demand Factor (%)	Calculated Loads (VA)
Total VA/m ²	Total VA/ft ²		
0–33	0–3	100	Amount × 100%
Over 33–220	Over 3–20	75	(Amount × 75%) + 3
Remainder over 220	Remainder over 20	25	(Amount × 25%) + 15.75

Δ 220.87 Determining Existing Loads. The calculation of a feeder or service load for existing installations shall be permitted to use actual maximum demand to determine the existing load under all of the following conditions:

- (1) The maximum demand data is available for a 1-year period.

Exception: If the maximum demand data for a 1-year period is not available, the calculated load shall be permitted to be based on the maximum demand (the highest average kilowatts reached and maintained for a 15-minute interval) continuously recorded over a minimum 30-day period using a recording ammeter or power meter connected to the highest loaded phase of the feeder or service, based on the initial loading at the start of the recording. The recording shall reflect the maximum demand of the feeder or service by being taken when the building or space is occupied and shall include by measurement or calculation the larger of the heating or cooling equipment load, and other loads that might be periodic in nature due to seasonal or similar conditions. This exception shall not be permitted if the feeder or service has a renewable energy system (i.e., solar photovoltaic or wind electric) or employs any form of peak load shaving.

- (2) The maximum demand at 125 percent plus the new load does not exceed the ampacity of the feeder or rating of the service.
- (3) The feeder has overcurrent protection in accordance with 240.4, and the service has overload protection in accordance with 230.90.

220.88 New Restaurants. Calculation of a service or feeder load, where the feeder serves the total load, for a new restaurant shall be permitted in accordance with Table 220.88 in lieu of Part III of this article.

The overload protection of the service conductors shall be in accordance with 230.90 and 240.4.

Feeder conductors shall not be required to be of greater ampacity than the service conductors.

Service or feeder conductors whose calculated load is determined by this optional calculation shall be permitted to have the neutral load determined by 220.61.

Part V. Farm Load Calculations

220.100 General. Farm loads shall be calculated in accordance with Part V.

220.102 Farm Loads — Buildings and Other Loads.

(A) Dwelling Unit. The feeder or service load of a farm dwelling unit shall be calculated in accordance with the provisions for dwellings in Part III or IV of this article. Where the dwelling has electric heat and the farm has electric grain-drying systems, Part IV of this article shall not be used to calculate the dwelling load where the dwelling and farm loads are supplied by a common service.

(B) Other Than Dwelling Unit. Where a feeder or service supplies a farm building or other load having two or more separate branch circuits, the load for feeders, service conductors, and service equipment shall be calculated in accordance with demand factors not less than indicated in Table 220.102(B).

Table 220.88 Optional Method — Permitted Load Calculations for Service and Feeder Conductors for New Restaurants

Total Connected Load (kVA)	All Electric Restaurant	Not All Electric Restaurant
	Calculated Loads (kVA)	Calculated Loads (kVA)
0–200	80%	100%
201–325	10% (amount over 200) + 160.0	50% (amount over 200) + 200.0
326–800	50% (amount over 325) + 172.5	45% (amount over 325) + 262.5
Over 800	50% (amount over 800) + 410.0	20% (amount over 800) + 476.3

Note: Add all electrical loads, including both heating and cooling loads, to calculate the total connected load. Select the one demand factor that applies from the table, then multiply the total connected load by this single demand factor.

220.103 Farm Loads — Total. Where supplied by a common service, the total load of the farm for service conductors and service equipment shall be calculated in accordance with the farm dwelling unit load and demand factors specified in Table 220.103. Where there is equipment in two or more farm equipment buildings or for loads having the same function, such loads shall be calculated in accordance with Table 220.102(B) and shall be permitted to be combined as a single load in Table 220.103 for calculating the total load.

Part VI. Health Care Facilities

220.110 Receptacle Loads. Receptacle loads calculated in accordance with 220.14(H) and (I) and supplied by branch circuits not exceeding 150 volts to ground shall be permitted to be subjected to the demand factors provided in Table 220.110(1) and Table 220.110(2) for health care facilities.

Informational Note No. 1: See Article 100 for the definitions of patient care space categories.

Informational Note No. 2: See 220.14(I) for the calculation of receptacle outlet loads.

Part VII. Marinas, Boatyards, Floating Buildings, and Commercial and Noncommercial Docking Facilities

220.120 Receptacle Loads. General lighting and other loads in marinas, boatyards, floating buildings, and commercial and noncommercial docking facilities shall be calculated in accordance with Part III of this article and, in addition, the demand factors set forth in Table 220.120 shall be permitted for each service or feeder circuit supplying receptacles that provide shore power for boats. These calculations shall be permitted to be modified as indicated in Notes (1) and (2) of Table 220.120. Where demand factors of Table 220.120 are applied, the demand factor specified in 220.61 (B) shall not be permitted.

Informational Note: These demand factors could be inadequate in areas of extreme hot or cold temperatures with loaded circuits for heating, air-conditioning, or refrigerating equipment.

Table 220.102(B) Method for Calculating Farm Loads for Other Than Dwelling Unit

Ampere Load at 240 Volts Maximum	Demand Factor (%)
The greater of the following: All loads that are expected to operate simultaneously, or 125 percent of the full load current of the largest motor, or First 60 amperes of the load	100
Next 60 amperes of all other loads	50
Remainder of other loads	25

Table 220.103 Method for Calculating Total Farm Load

Individual Loads Calculated in Accordance with Table 220.102	Demand Factor (%)
Largest load	100
Second largest load	75
Third largest load	65
Remaining loads	50

Note: To this total load, add the load of the farm dwelling unit calculated in accordance with Part III or IV of this article. Where the dwelling has electric heat and the farm has electric grain-drying systems, Part IV of this article shall not be used to calculate the dwelling load.

Table 220.110(1) Demand Factors for Receptacles Supplied by General-Purpose Branch Circuits in Category 1 and Category 2 Patient Care Spaces

Portion of Receptacle Load to Which Demand Factor Applies (Volt-Amperes)	Demand Factor (%)
First 5000 or less	100
From 5001 to 10,000	50
Remainder over 10,000	25

N **Table 220.110(2) Demand Factors for Receptacles Supplied by General-Purpose Branch Circuits in Category 3 and Category 4 Patient Care Spaces**

Portion of Receptacle Load to Which Demand Factor Applies (Volt-Amperes)	Demand Factor (%)
First 10,000 or less	100
Remainder over 10,000	50

N **Table 220.120 Demand Factors for Shore Power Receptacle Loads**

Number of Shore Power Receptacles	Sum of the Rating of the Receptacles (%)
1–4	100
5–8	90
9–14	80
15–30	70
31–40	60
41–50	50
51–70	40
≥71	30

Notes:

- Where shore power accommodations provide two receptacles specifically for an individual boat slip and these receptacles have different voltages (e.g., one 30-ampere, 125-volt and one 50-ampere, 125/250-volt), only the receptacle with the larger kilowatt demand shall be required to be calculated.
- For each shore powered pedestal being installed that includes an individual kilowatt-hour submeters for each slip and is being calculated using the criteria listed in Table 220.120, the total demand amperes shall be permitted to be multiplied by 0.9 to achieve the final demand amperes of the facility.
- If a circuit feeding a boat hoist and shore power for the same boat slip is shared, only the load with the larger kilowatt demand shall be required to be counted in the load calculation.

ARTICLE 225 Outside Branch Circuits and Feeders

N Part I. General

225.1 Scope. This article covers requirements for outside branch circuits and feeders not over 1000 volts ac or 1500 volts dc, nominal, run on or between buildings, structures, or poles on the premises; and electrical equipment and wiring for the supply of utilization equipment that is located on or attached to the outside of buildings, structures, or poles.

Informational Note: See Part IV of Article 235 for outside branch circuits and feeders over 1000 volts ac or 1500 volts dc.

225.3 Other Articles. Application of other articles, including additional requirements to specific cases of equipment and conductors, is shown in Table 225.3.

225.4 Conductor Insulation. Where within 3.0 m (10 ft) of any building or structure other than supporting poles or towers, open individual (aerial) overhead conductors shall be insulated for the nominal voltage. The insulation of conductors in cables

Δ **Table 225.3 Other Articles**

Equipment/Conductors	Article
Branch circuits	210
Class 1 power-limited circuits and Class 1 power-limited remote-control and signaling circuits	724
Class 2 and Class 3 remote-control, signaling, and power-limited circuits	725
Conductors for general wiring	310
Electrically driven or controlled irrigation machines	675
Electric signs and outline lighting	600
Feeders	215
Fire alarm systems	760
Fixed outdoor electric deicing and snow-melting equipment	426
Grounding and bonding	250
Hazardous (classified) locations	500
Hazardous (classified) locations — specific	510
Marinas and boatyards	555
Medium-voltage conductors and cable	311
Messenger-supported wiring	396
Mobile homes, manufactured homes, and mobile home parks	550
Open wiring on insulators	398
Over 1000 volts, general	495
Overcurrent protection	240
Overcurrent protection for systems rated over 1000 volts ac, 1500 volts dc	245
Services	230
Services, feeders, and branch circuits over 1000 volts ac, 1500 volts dc	235
Solar photovoltaic systems	690
Swimming pools, fountains, and similar installations	680
Use and identification of grounded conductors	200

or raceways, except Type MI cable, shall be of thermoset or thermoplastic type and, in wet locations, shall comply with 310.10(C). The insulation of conductors for festoon lighting shall be of the thermoset or thermoplastic type.

Exception: Equipment grounding conductors and grounded circuit conductors shall be permitted to be bare or covered as specifically permitted elsewhere in this Code.

• **225.6 Conductor Size and Support.**

Δ (A) Overhead Spans. Open individual conductors shall not be smaller than 10 AWG copper or 8 AWG aluminum for spans up to 15 m (50 ft) in length, and 8 AWG copper or 6 AWG aluminum for a longer span unless supported by a messenger wire.

(B) Festoon Lighting. Overhead conductors for festoon lighting shall not be smaller than 12 AWG unless the conductors are supported by messenger wires. In all spans exceeding 12 m (40 ft), the conductors shall be supported by messenger wire. The messenger wire shall be supported by strain insulators. Conductors or messenger wires shall not be attached to any fire escape, downspout, or plumbing equipment.

Δ 225.10 Wiring on Buildings (or Other Structures). The installation of outside wiring on surfaces of buildings (or other structures) shall be permitted for circuits not exceeding 1000 volts, nominal, as the following:

- (1) Auxiliary gutters
- (2) Busways

- (3) Cable trays
- (4) Cablebus
- (5) Electrical metallic tubing (EMT)
- (6) Flexible metal conduit (FMC)
- (7) Intermediate metal conduit (IMC)
- (8) Liquidtight flexible metal conduit (LFMC)
- (9) Liquidtight flexible nonmetallic conduit (LFNC)
- (10) Messenger-supported wiring
- (11) Open wiring on insulators
- (12) Reinforced thermosetting resin conduit (RTRC)
- (13) Rigid metal conduit (RMC)
- (14) Rigid polyvinyl chloride conduit (PVC)
- (15) Type MC cable
- (16) Type MI cable
- (17) Type SE cable
- (18) Type TC-ER cable
- (19) Type UF cable
- (20) Wireways

Δ 225.11 Feeder and Branch-Circuit Conductors Entering, Exiting, or Attached to Buildings or Structures. Feeder and branch-circuit conductors entering or exiting buildings or structures shall be installed in accordance with 230.52. Overhead branch circuits and feeders attached to buildings or structures shall be installed in accordance with 230.54.

225.12 Open-Conductor Supports. Open conductors shall be supported on knobs, racks, brackets, or strain insulators, that are made of glass, porcelain, or other approved materials.

225.14 Open-Conductor Spacings. Conductors shall comply with the spacings provided in Table 230.51(C).

(A) Separation from Other Circuits. Open conductors shall be separated from open conductors of other circuits or systems by not less than 100 mm (4 in.).

(B) Conductors on Poles. Conductors on poles shall have a separation of not less than 300 mm (1 ft) where not placed on racks or brackets. Conductors supported on poles shall provide a horizontal climbing space not less than the following:

- (1) Power conductors below communications conductors — 750 mm (30 in.)
- (2) Power conductors alone or above communications conductors:
 - a. 300 volts or less — 600 mm (24 in.)
 - b. Over 300 volts — 750 mm (30 in.)
- (3) Communications conductors below power conductors — same as power conductors
- (4) Communications conductors alone — no requirement

• 225.15 Supports over Buildings. Outside branch-circuit and feeder conductors passing over a building shall be securely supported.

225.16 Attachment to Buildings.

(A) Point of Attachment. The point of attachment to a building shall be in accordance with 230.26.

(B) Means of Attachment. The means of attachment to a building shall be in accordance with 230.27.

225.17 Masts as Supports. Only feeder or branch-circuit conductors specified within this section shall be permitted to be attached to the feeder and/or branch-circuit mast. Masts used for the support of final spans of feeders or branch circuits shall be installed in accordance with 225.17(A) and (B).

(A) Strength. The mast shall have adequate strength or be supported by braces or guy wires to safely withstand the strain imposed by the overhead feeder or branch-circuit conductors. Hubs intended for use with a conduit serving as a mast for support of feeder or branch-circuit conductors shall be identified for use with a mast.

(B) Attachment. Feeder and/or branch-circuit conductors shall not be attached to a mast where the connection is between a weatherhead or the end of the conduit and a coupling where the coupling is located above the last point of securement to the building or other structure, or where the coupling is located above the building or other structure.

225.18 Clearance for Overhead Conductors and Cables. Overhead spans of open conductors and open multiconductor cables of not over 1000 volts, nominal, shall have a clearance of not less than the following:

- (1) 3.0 m (10 ft) — above finished grade, sidewalks, or from any platform or projection that will permit personal contact where the voltage does not exceed 150 volts to ground and accessible to pedestrians only
- (2) 3.7 m (12 ft) — over residential property and driveways, and those commercial areas not subject to truck traffic where the voltage does not exceed 300 volts to ground
- (3) 4.5 m (15 ft) — for those areas listed in the 3.7 m (12 ft) classification where the voltage exceeds 300 volts to ground
- (4) 5.5 m (18 ft) — over public streets, alleys, roads, parking areas subject to truck traffic, driveways on other than residential property, and other land traversed by vehicles, such as cultivated, grazing, forest, and orchard
- (5) 7.5 m (24½ ft) — over track rails of railroads

225.19 Clearances from Buildings for Conductors of Not over 1000 Volts, Nominal. Overhead spans of open conductors and open multiconductor cables shall comply with 225.19(A), (B), (C), and (D).

(A) Above Roofs. Overhead spans of open conductors and open multiconductor cables shall have a vertical clearance of not less than 2.6 m (8 ft 6 in.) above the roof surface. The vertical clearance above the roof level shall be maintained for a distance not less than 900 mm (3 ft) in all directions from the edge of the roof.

Exception No. 1: The area above a roof surface subject to pedestrian or vehicular traffic shall have a vertical clearance from the roof surface in accordance with the clearance requirements of 225.18.

Exception No. 2: Where the voltage between conductors does not exceed 300, and the roof has a slope of 100 mm in 300 mm (4 in. in 12 in.) or greater, a reduction in clearance to 900 mm (3 ft) shall be permitted.

Exception No. 3: Where the voltage between conductors does not exceed 300, a reduction in clearance above only the overhanging portion of the roof to not less than 450 mm (18 in.) shall be permitted if (1) not more than 1.8 m (6 ft) of the conductors, 1.2 m (4 ft) horizontally, pass above the roof overhang, and (2) they are terminated at a through-the-roof raceway or approved support.

Exception No. 4: The requirement for maintaining the vertical clearance 900 mm (3 ft) from the edge of the roof shall not apply to the final conductor span where the conductors are attached to the side of a building.

(B) From Nonbuilding or Nonbridge Structures. From signs, chimneys, radio and television antennas, tanks, and other

nonbuilding or nonbridge structures, clearances — vertical, diagonal, and horizontal — shall not be less than 900 mm (3 ft).

(C) Horizontal Clearances. Clearances shall not be less than 900 mm (3 ft).

(D) Final Spans. Final spans of feeders or branch circuits shall comply with 225.19(D)(1), (D)(2), and (D)(3).

(1) Clearance from Windows. Final spans to the building they supply, or from which they are fed, shall be permitted to be attached to the building, but they shall be kept not less than 900 mm (3 ft) from windows that are designed to be opened, and from doors, porches, balconies, ladders, stairs, fire escapes, or similar locations.

Exception: Conductors run above the top level of a window shall be permitted to be less than the 900 mm (3 ft) requirement.

(2) Vertical Clearance. The vertical clearance of final spans above or within 900 mm (3 ft) measured horizontally of platforms, projections, or surfaces that will permit personal contact shall be maintained in accordance with 225.18.

(3) Building Openings. The overhead branch-circuit and feeder conductors shall not be installed beneath openings through which materials may be moved, such as openings in farm and commercial buildings, and shall not be installed where they obstruct entrance to these openings.

(E) Zone for Fire Ladders. Where buildings exceed three stories or 15 m (50 ft) in height, overhead lines shall be arranged, where practicable, so that a clear space (or zone) at least 1.8 m (6 ft) wide will be left either adjacent to the buildings or beginning not over 2.5 m (8 ft) from them to facilitate the raising of ladders when necessary for fire fighting.

225.20 Protection Against Physical Damage. Conductors installed on buildings, structures, or poles shall be protected against physical damage as provided for services in 230.50.

225.21 Multiconductor Cables on Exterior Surfaces of Buildings (or Other Structures). Supports for multiconductor cables on exterior surfaces of buildings (or other structures) shall be as provided in 230.51.

225.22 Raceways on Exterior Surfaces of Buildings or Other Structures. Raceways on exteriors of buildings or other structures shall be arranged to drain and shall be listed or approved for use in wet locations.

225.24 Outdoor Lampholders. Where outdoor lampholders are attached as pendants, the connections to the circuit wires shall be staggered. Where such lampholders have terminals of a type that puncture the insulation and make contact with the conductors, they shall be attached only to conductors of the stranded type.

225.25 Location of Outdoor Lamps. Locations of lamps for outdoor lighting shall be below all energized conductors, transformers, or other electric utilization equipment, unless either of the following apply:

- (1) Clearances or other safeguards are provided for relamping operations.
- (2) Equipment is controlled by a disconnecting means that is lockable open in accordance with 110.25.

225.26 Vegetation as Support. Vegetation such as trees shall not be used for support of overhead conductor spans.

225.27 Raceway Seal. Where a raceway enters a building or structure from outside, it shall be sealed in accordance with 300.5(G) and 300.7(A). Spare or unused raceways shall also be sealed. Sealants shall be identified for use with cable insulation, conductor insulation, bare conductor, shield, or other components.

Part II. Buildings or Other Structures Supplied by a Feeder(s) or Branch Circuit(s)

225.30 Number of Supplies. A building or other structure that is served by a branch circuit or feeder on the load side of a service disconnecting means shall be supplied by only one feeder or branch circuit unless permitted in 225.30(A) through (F). For the purpose of this section, a multiwire branch circuit shall be considered a single circuit.

Where a branch circuit or feeder originates in these additional buildings or other structures, only one feeder or branch circuit shall be permitted to supply power back to the original building or structure, unless permitted in 225.30(A) through (F).

(A) Special Conditions. Additional feeders or branch circuits shall be permitted to supply the following:

- (1) Fire pumps
- (2) Emergency systems
- (3) Legally required standby systems
- (4) Optional standby systems
- (5) Parallel power production systems
- (6) Systems designed for connection to multiple sources of supply for the purpose of enhanced reliability
- (7) Electric vehicle power transfer systems listed, labeled, and identified for more than a single branch circuit or feeder
- (8) Docking facilities and piers

(B) Common Supply Equipment. Where feeder conductors originate in the same panelboard, switchboard, or other distribution equipment, and each feeder terminates in a single disconnecting means, not more than six feeders shall be permitted. Where more than one feeder is installed in accordance with this section, all feeder disconnects supplying the building or structure shall be grouped in the same location, and the requirements of 225.33 shall not apply. Each disconnect shall be marked to indicate the load served.

(C) Special Occupancies. By special permission, additional feeders or branch circuits shall be permitted for either of the following:

- (1) Multiple-occupancy buildings where there is no space available for supply equipment accessible to all occupants
- (2) A single building or other structure sufficiently large to make two or more supplies necessary

(D) Capacity Requirements. Additional feeders or branch circuits shall be permitted where the capacity requirements are in excess of 2000 amperes at a supply voltage of 1000 volts or less.

(E) Different Characteristics. Additional feeders or branch circuits shall be permitted for different voltages, frequencies, or phases, or for different uses such as control of outside lighting from multiple locations.

Δ (F) Documented Switching Procedures. Additional feeders or branch circuits shall be permitted to supply installations under single management where documented safe switching procedures are established and maintained.

Δ 225.31 Disconnecting Means.

N (A) General. Means shall be provided for disconnecting all ungrounded conductors that supply or pass through the building or structure.

Δ (B) Location. The disconnecting means shall be installed either inside or outside of the building or structure served or where the conductors pass through the building or structure. The disconnecting means shall be at a readily accessible location nearest the point of entrance of the conductors. For the purposes of this section, the requirements in 230.6 shall apply.

Exception No. 1: For installations under single management, where documented safe switching procedures are established and maintained, and where the installation is monitored by qualified individuals, the disconnecting means shall be permitted to be located elsewhere on the premises.

Exception No. 2: For buildings or other structures qualifying under 685.1, the disconnecting means shall be permitted to be located elsewhere on the premises.

Exception No. 3: For towers or poles used as lighting standards, the disconnecting means shall be permitted to be located elsewhere on the premises.

Exception No. 4: For poles or similar structures used only for support of signs installed in accordance with 600.1, the disconnecting means shall be permitted to be located elsewhere on the premises.

225.33 Maximum Number of Disconnects.

(A) General. The disconnecting means for each supply permitted by 225.30 shall consist of not more than six switches or six circuit breakers mounted in a single enclosure, in a group of separate enclosures, or in or on a switchboard or switchgear. There shall be no more than six disconnects per supply grouped in any one location.

Exception: For the purposes of this section, disconnecting means used solely for the control circuit of the ground-fault protection system, or the control circuit of the power-operated supply disconnecting means, installed as part of the listed equipment, shall not be considered a supply disconnecting means.

(B) Single-Pole Units. Two or three single-pole switches or breakers capable of individual operation shall be permitted on multiwire circuits, one pole for each ungrounded conductor, as one multipole disconnect, provided they are equipped with identified handle ties or a master handle to disconnect all ungrounded conductors with no more than six operations of the hand.

225.34 Grouping of Disconnects.

(A) General. The two to six disconnects as permitted in 225.33 shall be grouped. Each disconnect shall be marked to indicate the load served.

Exception: One of the two to six disconnecting means permitted in 225.33, where used only for a water pump also intended to provide fire protection, shall be permitted to be located remote from the other disconnecting means.

(B) Additional Disconnecting Means. The one or more additional disconnecting means for fire pumps or for emergency, legally required standby or optional standby system permitted by 225.30 shall be installed sufficiently remote from the one to six disconnecting means for normal supply to minimize the possibility of simultaneous interruption of supply.

225.35 Access to Occupants. In a multiple-occupancy building, each occupant shall have access to the occupant's supply disconnecting means.

Exception: In a multiple-occupancy building where electric supply and electrical maintenance are provided by the building management and where these are under continuous building management supervision, the supply disconnecting means supplying more than one occupancy shall be permitted to be accessible to authorized management personnel only.

Δ 225.36 Type of Disconnecting Means. The disconnecting means specified in 225.31 shall be a circuit breaker, molded case switch, general-use switch, snap switch, or other approved means. Where applied in accordance with 250.32(B)(1), Exception No. 1, the disconnecting means shall be suitable for use as service equipment.

225.37 Identification. Where a building or structure has any combination of feeders, branch circuits, or services passing through it or supplying it, a permanent plaque or directory shall be installed at each feeder and branch-circuit disconnect location denoting all other services, feeders, or branch circuits supplying that building or structure or passing through that building or structure and the area served by each.

Exception No. 1: A plaque or directory shall not be required for large-capacity multibuilding industrial installations under single management, where it is ensured that disconnection can be accomplished by establishing and maintaining safe switching procedures.

Exception No. 2: This identification shall not be required for branch circuits installed from a dwelling unit to a second building or structure.

225.38 Disconnect Construction. Disconnecting means shall meet the requirements of 225.38(A) through (D).

(A) Manually or Power Operable. The disconnecting means shall consist of either (1) a manually operable switch or a circuit breaker equipped with a handle or other suitable operating means or (2) a power-operable switch or circuit breaker, provided the switch or circuit breaker can be opened by hand in the event of a power failure.

(B) Simultaneous Opening of Poles. Each building or structure disconnecting means shall simultaneously disconnect all ungrounded supply conductors that it controls from the building or structure wiring system.

(C) Disconnection of Grounded Conductor. Where the building or structure disconnecting means does not disconnect the grounded conductor from the grounded conductors in the building or structure wiring, other means shall be provided for this purpose at the location of the disconnecting means. A terminal or bus to which all grounded conductors can be attached by means of pressure connectors shall be permitted for this purpose.

In a multisection switchboard or switchgear, disconnects for the grounded conductor shall be permitted to be in any section of the switchboard or switchgear, if the switchboard section or

switchgear section is marked to indicate a grounded conductor disconnect is contained within the equipment.

(D) Indicating. The building or structure disconnecting means shall plainly indicate whether it is in the open or closed position.

225.39 Rating of Disconnect. The feeder or branch-circuit disconnecting means shall have a rating of not less than the calculated load to be supplied, determined in accordance with Parts I and II of Article 220 for branch circuits, Part III or IV of Article 220 for feeders, or Part V of Article 220 for farm loads. Where the branch circuit or feeder disconnecting means consists of more than one switch or circuit breaker, as permitted by 225.33, combining the ratings of all the switches or circuit breakers for determining the rating of the disconnecting means shall be permitted. In no case shall the rating be lower than specified in 225.39(A), (B), (C), or (D).

(A) One-Circuit Installation. For installations to supply only limited loads of a single branch circuit, the branch circuit disconnecting means shall have a rating of not less than 15 amperes.

(B) Two-Circuit Installations. For installations consisting of not more than two 2-wire branch circuits, the feeder or branch-circuit disconnecting means shall have a rating of not less than 30 amperes.

(C) One-Family Dwelling. For a one-family dwelling, the feeder disconnecting means shall have a rating of not less than 100 amperes, 3-wire.

(D) All Others. For all other installations, the feeder or branch-circuit disconnecting means shall have a rating of not less than 60 amperes.

225.40 Access to Overcurrent Protective Devices. Where a feeder overcurrent device is not readily accessible, branch-circuit overcurrent devices shall be installed on the load side, shall be mounted in a readily accessible location, and shall be of a lower ampere rating than the feeder overcurrent device.

225.41 Emergency Disconnects. For one-and two-family dwelling units, an emergency disconnecting means shall be installed.

(A) General.

(1) Location. The disconnecting means shall be installed in a readily accessible outdoor location on or within sight of the dwelling unit.

(2) Rating. The disconnecting means shall have a short-circuit current rating equal to or greater than the available fault current.

(3) Grouping. If more than one disconnecting means is provided, they shall be grouped.

(B) Identification of Other Isolation Disconnects. Where equipment for isolation of other energy source systems is not located adjacent to the emergency disconnect required by this section, a plaque or directory identifying the location of all equipment for isolation of other energy sources shall be located adjacent to the disconnecting means required by this section.

Informational Note: See 445.18, 480.7, 705.20, and 706.15 for examples of other energy source system isolation means.

(C) Marking. The disconnecting means shall be marked as EMERGENCY DISCONNECT.

Markings shall comply with 110.21(B) and all of the following:

- (1) The marking or labels shall be located on the outside front of the disconnect enclosure with red background and white text.
- (2) The letters shall be least 13 mm (½ in.) high.

225.42 Surge Protection.

(A) Surge-Protective Device. Where a feeder supplies any of the following, a surge-protective device (SPD) shall be installed:

- (1) Dwelling units
- (2) Dormitory units
- (3) Guest rooms and guest suites of hotels and motels
- (4) Areas of nursing homes and limited-care facilities used exclusively as patient sleeping rooms

(B) Location. The SPD shall be installed in or adjacent to the distribution equipment that is connected to the load side of the feeder and contains branch circuit overcurrent protective device(s) that supply the location specified in 225.42(A).

Informational Note: Surge protection is most effective when closest to the branch circuit. Surges can be generated from multiple sources including, but not limited to, lightning, the electric utility, or utilization equipment.

(C) Type. The SPD shall be a Type 1 or Type 2 SPD.

(D) Replacement. Where the distribution equipment supplied by the feeder is replaced, all of the requirements of this section shall apply.

(E) Ratings. SPDs shall have a nominal discharge current rating (I_n) of not less than 10kA.

Informational Note: Lead lengths of conductors to the SPD should be kept as short as possible to reduce let-through voltages.

ARTICLE 230 Services

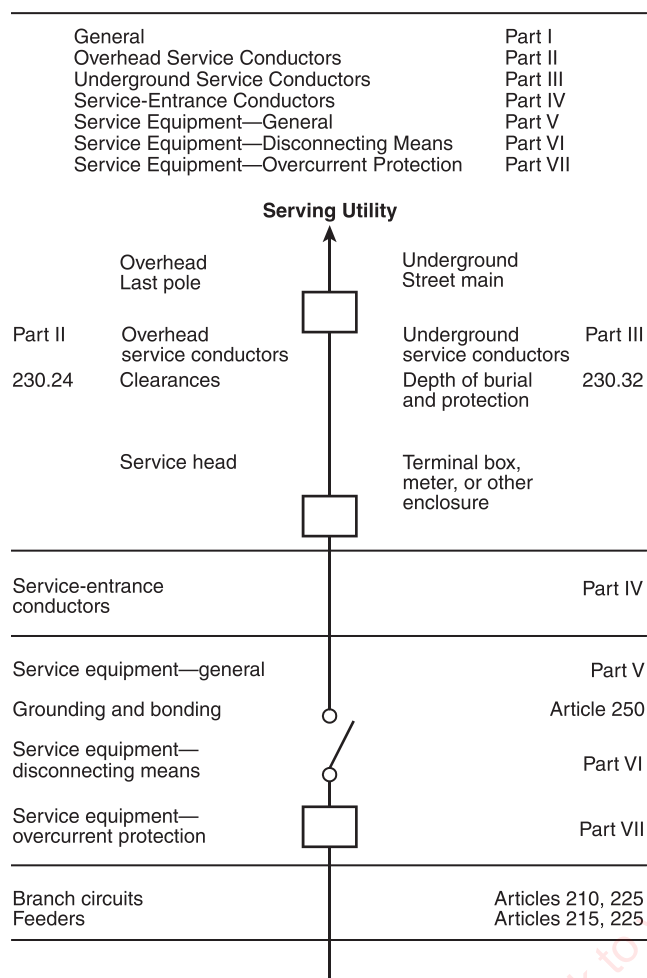
Part I. General

230.1 Scope. This article covers service conductors and equipment for control and protection of services not over 1000 volts ac or 1500 volts dc, nominal and their installation requirements.

Informational Note No. 1: See Informational Note Figure 230.1.

Informational Note No. 2: See Part V of Article 235 for services over 1000 volts ac or 1500 volts dc, nominal.

230.2 Number of Services. A building or other structure served shall be supplied by only one service unless permitted in 230.2(A) through (D). For the purpose of 230.40, Exception No. 2 only, underground sets of conductors, 1/0 AWG and larger, running to the same location and connected together at



▲ Informational Note Figure 230.1 Services.

their supply end but not connected together at their load end shall be considered to be supplying one service.

(A) Special Conditions. Additional services shall be permitted to supply the following:

- (1) Fire pumps
- (2) Emergency systems
- (3) Legally required standby systems
- (4) Optional standby systems
- (5) Interconnected electric power production sources
- (6) Systems designed for connection to multiple sources of supply for the purpose of enhanced reliability

(B) Special Occupancies. By special permission, additional services shall be permitted for either of the following:

- (1) Multiple-occupancy buildings where there is no available space for service equipment accessible to all occupants
- (2) A single building or other structure sufficiently large to make two or more services necessary

(C) Capacity Requirements. Additional services shall be permitted under any of the following:

- (1) Where the capacity requirements are in excess of 2000 amperes at a supply voltage of 1000 volts or less

- (2) Where the load requirements of a single-phase installation are greater than the serving agency normally supplies through one service
- (3) By special permission

(D) Different Characteristics. Additional services shall be permitted for different voltages, frequencies, or phases, or for different uses, such as for different rate schedules.

(E) Identification. Where a building or structure is supplied by more than one service, or any combination of branch circuits, feeders, and services, a permanent plaque or directory shall be installed at each service disconnect location denoting all other services, feeders, and branch circuits supplying that building or structure and the area served by each. See 225.37.

230.3 One Building or Other Structure Not to Be Supplied Through Another. Service conductors supplying a building or other structure shall not pass through the interior of another building or other structure.

▲ **230.6 Conductors Considered Outside the Building.** Conductors shall be considered outside of a building or other structure under any of the following conditions:

- (1) Where installed under not less than 50 mm (2 in.) of concrete beneath a building or other structure
- (2) Where installed within a building or other structure in a raceway that is encased in concrete or brick not less than 50 mm (2 in.) thick
- (3) Where installed in any vault that meets the construction requirements of Part III of Article 450
- (4) Where installed in conduit and under not less than 450 mm (18 in.) of earth beneath a building or other structure
- (5) Where installed within rigid metal conduit (RMC) or intermediate metal conduit (IMC) used to accommodate the clearance requirements in 230.24 and routed directly through an eave but not a wall of a building

▲ **230.7 Other Conductors.** Circuit conductors other than service conductors, shall not be installed in the same raceway, cable, handhole enclosure, or underground box as the service conductors.

Exception No. 1: Grounding electrode conductors or supply side bonding jumpers or conductors shall be permitted within service raceways.

Exception No. 2: Load management control conductors having overcurrent protection shall be permitted within service raceways.

▲ **230.8 Raceway Seal.** Where a service raceway enters a building or structure, it shall be sealed in accordance with 300.5(G) and 300.7(A). Spare or unused raceways shall also be sealed. Sealants shall be identified for use with the cable insulation, conductor insulation, bare conductor, shield, or other components.

230.9 Clearances on Buildings. Service conductors and final spans shall comply with 230.9(A), (B), and (C).

(A) Clearances. Service conductors installed as open conductors or multiconductor cable without an overall outer jacket shall have a clearance of not less than 900 mm (3 ft) from windows that are designed to be opened, doors, porches, balconies, ladders, stairs, fire escapes, or similar locations.

Exception: Conductors run above the top level of a window shall be permitted to be less than the 900 mm (3 ft) requirement.

(B) Vertical Clearance. The vertical clearance of final spans above, or within 900 mm (3 ft) measured horizontally of plat-forms, projections, or surfaces that will permit personal contact shall be maintained in accordance with 230.24(B).

(C) Building Openings. Overhead service conductors shall not be installed beneath openings through which materials may be moved, such as openings in farm and commercial buildings, and shall not be installed where they obstruct entrance to these building openings.

230.10 Vegetation as Support. Vegetation such as trees shall not be used for support of overhead service conductors or service equipment.

Part II. Overhead Service Conductors

230.22 Insulation or Covering. Individual conductors shall be insulated or covered.

Exception: The grounded conductor of a multiconductor cable shall be permitted to be bare.

230.23 Size and Ampacity.

(A) General. Conductors shall have sufficient ampacity to carry the current for the load as calculated in accordance with Parts II through V of Article 220 and shall have adequate mechanical strength.

(B) Minimum Size. The conductors shall not be smaller than 8 AWG copper or 6 AWG aluminum or copper-clad aluminum.

Exception: Conductors supplying only limited loads of a single branch circuit — such as small polyphase power, controlled water heaters, and similar loads — shall not be smaller than 12 AWG hard-drawn copper or equivalent.

(C) Grounded Conductors. The grounded conductor shall not be less than the minimum size as required by 250.24(D).

230.24 Clearances. Overhead service conductors shall not be readily accessible and shall comply with 230.24(A) through (E) for services not over 1000 volts, nominal.

(A) Above Roofs. Conductors shall have a vertical clearance of not less than 2.6 m (8 ft 6 in.) above the roof surface. The vertical clearance above the roof level shall be maintained for a distance of not less than 900 mm (3 ft) in all directions from the edge of the roof.

Exception No. 1: The area above a roof surface subject to pedestrian or vehicular traffic shall have a vertical clearance from the roof surface in accordance with the clearance requirements of 230.24(B).

Exception No. 2: Where the voltage between conductors does not exceed 300 and the roof has a slope of 100 mm in 300 mm (4 in. in 12 in.) or greater, a reduction in clearance to 900 mm (3 ft) shall be permitted.

Exception No. 3: Where the voltage between conductors does not exceed 300, a reduction in clearance above only the overhanging portion of the roof to not less than 450 mm (18 in.) shall be permitted if (1) not more than 1.8 m (6 ft) of overhead service conductors, 1.2 m (4 ft) horizontally, pass above the roof overhang, and (2) they are terminated at a through-the-roof raceway or approved support.

Informational Note: See 230.28 for mast supports.

Exception No. 4: The requirement for maintaining the vertical clearance 900 mm (3 ft) from the edge of the roof shall not apply to the final

conductor span where the service drop or overhead service conductors are attached to the side of a building.

Exception No. 5: Where the voltage between conductors does not exceed 300 and the roof area is guarded or isolated, a reduction in clearance to 900 mm (3 ft) shall be permitted.

(B) Vertical Clearance for Overhead Service Conductors. Overhead service conductors, where not in excess of 1000 volts, nominal, shall have the following minimum clearance from final grade:

- (1) 3.0 m (10 ft) — at the electrical service entrance to buildings, also at the lowest point of the drip loop of the building electrical entrance, and above areas or sidewalks accessible only to pedestrians, measured from final grade or other accessible surface only for overhead service conductors supported on and cabled together with a grounded bare messenger where the voltage does not exceed 150 volts to ground
- (2) 3.7 m (12 ft) — over residential property and driveways, and those commercial areas not subject to truck traffic where the voltage does not exceed 300 volts to ground
- (3) 4.5 m (15 ft) — for those areas listed in the 3.7 m (12 ft) classification where the voltage exceeds 300 volts to ground
- (4) 5.5 m (18 ft) — over public streets, alleys, roads, parking areas subject to truck traffic, driveways on other than residential property, and other land such as cultivated, grazing, forest, and orchard
- (5) 7.5 m (24½ ft) over tracks of railroads

(C) Clearance from Building Openings. Clearances from building openings shall comply with 230.9(C).

(D) Clearance from Swimming Pools, Fountains, and Similar Installations. Clearances from swimming pools, fountains, and similar installations shall comply with 680.9.

(E) Clearance from Communication Wires and Cables. Clearance from communication wires and cables shall be in accordance with 800.44(A)(4).

230.26 Point of Attachment. The point of attachment of the overhead service conductors to a building or other structure shall provide the minimum clearances as specified in 230.9 and 230.24. In no case shall this point of attachment be less than 3.0 m (10 ft) above finished grade.

230.27 Means of Attachment. Multiconductor cables used for overhead service conductors shall be attached to buildings or other structures by fittings identified for use with service conductors. Open conductors shall be attached to fittings identified for use with service conductors or to noncombustible, nonabsorbent insulators securely attached to the building or other structure.

230.28 Service Masts as Supports. Only power service-drop or overhead service conductors shall be permitted to be attached to a service mast. Service masts used for the support of service-drop or overhead service conductors shall be installed in accordance with 230.28(A) and (B).

(A) Strength. The service mast shall be of adequate strength or be supported by braces or guy wires to withstand safely the strain imposed by the service-drop or overhead service conductors. Hubs intended for use with a conduit that serves as a service mast shall be identified for use with service-entrance equipment.

(B) Attachment. Service-drop or overhead service conductors shall not be attached to a service mast between a weatherhead or the end of the conduit and a coupling, where the coupling is located above the last point of securement to the building or other structure or is located above the building or other structure.

230.29 Supports over Buildings. Service conductors passing over a roof shall be securely supported by substantial structures. For a grounded system, where the substantial structure is metal, it shall be bonded by means of a bonding jumper and listed connector to the grounded overhead service conductor. Where practicable, such supports shall be independent of the building.

Part III. Underground Service Conductors

230.30 Installation.

(A) Insulation. Underground service conductors shall be insulated for the applied voltage.

Exception: A grounded conductor shall be permitted to be uninsulated as follows:

- (1) Bare copper used in a raceway
- (2) Bare copper for direct burial where bare copper is approved for the soil conditions
- (3) Bare copper for direct burial without regard to soil conditions where part of a cable assembly identified for underground use
- (4) Aluminum or copper-clad aluminum without individual insulation or covering where part of a cable assembly identified for underground use in a raceway or for direct burial

Δ (B) Wiring Methods. Underground service conductors shall be installed in accordance with the applicable requirements of this Code covering the type of wiring method used and shall be limited to the following methods:

- (1) RMC conduit
- (2) IMC conduit
- (3) Type NUCC conduit
- (4) HDPE conduit
- (5) PVC conduit
- (6) RTRC conduit
- (7) Type IGS cable
- (8) Type USE conductors or cables
- (9) Type MV or Type MC cable identified for direct burial applications
- (10) Type MI cable where suitably protected against physical damage and corrosive conditions
- (11) Type TC-ER cable where identified for service entrance use and direct burial applications

230.31 Size and Ampacity.

(A) General. Underground service conductors shall have sufficient ampacity to carry the current for the load as calculated in accordance with Parts II through V of Article 220.

(B) Minimum Size. The conductors shall not be smaller than 8 AWG copper or 6 AWG aluminum or copper-clad aluminum.

Exception: Conductors supplying only limited loads of a single branch circuit — such as small polyphase power, controlled water heaters, and similar loads — shall not be smaller than 12 AWG copper or 10 AWG aluminum or copper-clad aluminum.

(C) Grounded Conductors. The grounded conductor shall not be smaller than the minimum size required by 250.24(D).

230.32 Protection Against Damage. Underground service conductors shall be protected against damage in accordance with 300.5. Service conductors entering a building or other structure shall be installed in accordance with 230.6 or protected by a raceway wiring method identified in 230.43.

230.33 Spliced Conductors. Service conductors shall be permitted to be spliced or tapped in accordance with 110.14, 230.46, 300.5(E), 300.13, and 300.15.

Part IV. Service-Entrance Conductors

230.40 Number of Service-Entrance Conductor Sets. Each service drop, set of overhead service conductors, set of underground service conductors, or service lateral shall supply only one set of service-entrance conductors.

Exception No. 1: A building with more than one occupancy shall be permitted to have one set of service-entrance conductors for each service, as permitted in 230.2, run to each occupancy or group of occupancies. If the number of service disconnect locations for any given classification of service does not exceed six, the requirements of 230.2(E) shall apply at each location. If the number of service disconnect locations exceeds six for any given supply classification, the following conditions shall apply:

- (1) All service disconnect locations for all supply characteristics, together with any branch circuit or feeder supply sources, shall be clearly described using graphics or text, or both, on one or more plaques
- (2) The plaques shall be located in an approved, readily accessible location(s) on the building or structure served and as near as practicable to the point(s) of attachment or entry(ies) for each service drop or service lateral and for each set of overhead or underground service conductors.

Exception No. 2: Where two to six service disconnecting means in separate enclosures are grouped at one location and supply separate loads from one service drop, set of overhead service conductors, set of underground service conductors, or service lateral, one set of service-entrance conductors shall be permitted to supply each or several such service equipment enclosures.

Exception No. 3: A one-family dwelling unit and its accessory structures shall be permitted to have one set of service-entrance conductors run to each from a single service drop, set of overhead service conductors, set of underground service conductors, or service lateral.

Exception No. 4: Two-family dwellings, multifamily dwellings, and multiple occupancy buildings shall be permitted to have one set of service-entrance conductors installed to supply the circuits covered in 210.25.

Exception No. 5: One set of service-entrance conductors connected to the supply side of the normal service disconnecting means shall be permitted to supply each or several systems covered by 230.82(5) or 230.82(6).

230.41 Insulation of Service-Entrance Conductors. Service-entrance conductors entering or on the exterior of buildings or other structures shall be insulated.

Exception: A grounded conductor shall be permitted to be uninsulated as follows:

- (1) Bare copper used in a raceway or part of a service cable assembly

- (2) Bare copper for direct burial where bare copper is approved for the soil conditions
- (3) Bare copper for direct burial without regard to soil conditions where part of a cable assembly identified for underground use
- (4) Aluminum or copper-clad aluminum without individual insulation or covering where part of a cable assembly or identified for underground use in a raceway, or for direct burial
- (5) Bare conductors used in an auxiliary gutter

230.42 Minimum Size and Ampacity.

Δ (A) General. Service-entrance conductors shall have an ampacity of not less than the maximum load to be served. Conductors shall be sized not less than the largest of 230.42(A)(1) or (A)(2). Loads shall be determined in accordance with Part III, IV, or V of Article 220, as applicable. Ampacity shall be determined from 310.14 and shall comply with 110.14(C). The maximum current of busways shall be that value for which the busway has been listed or labeled.

Informational Note: See UL 857, *Standard for Safety for Busways*, for information on busways.

N (1) Continuous and Noncontinuous Loads. Where the service-entrance conductors supply continuous loads or any combination of noncontinuous and continuous loads, the minimum service-entrance conductor size shall have an ampacity not less than the sum of the noncontinuous loads plus 125 percent of continuous loads.

Exception No. 1: Grounded conductors that are not connected to an overcurrent device shall be permitted to be sized at 100 percent of the sum of the continuous and noncontinuous load.

Exception No. 2: The sum of the noncontinuous load and the continuous load if the service-entrance conductors terminate in an overcurrent device where both the overcurrent device and its assembly are listed for operation at 100 percent of their rating shall be permitted.

N (2) Application of Adjustment or Correction Factors. The minimum service-entrance conductor size shall have an ampacity not less than the maximum load to be served after the application of any adjustment or correction factors.

(B) Specific Installations. In addition to the requirements of 230.42(A), the minimum ampacity for ungrounded conductors for specific installations shall not be less than the rating of the service disconnecting means specified in 230.79(A) through (D).

(C) Grounded Conductors. The grounded conductor shall not be smaller than the minimum size as required by 250.24(D).

230.43 Wiring Methods for 1000 Volts, Nominal, or Less. Service-entrance conductors shall be installed in accordance with the applicable requirements of this *Code* covering the type of wiring method used and shall be limited to the following methods:

- (1) Open wiring on insulators
- (2) Type IGS cable
- (3) Rigid metal conduit (RMC)
- (4) Intermediate metal conduit (IMC)
- (5) Electrical metallic tubing (EMT)
- (6) Electrical nonmetallic tubing
- (7) Service-entrance cables
- (8) Wireways
- (9) Busways

- (10) Auxiliary gutters
- (11) Rigid polyvinyl chloride conduit (PVC)
- (12) Cablebus
- (13) Type MC cable
- (14) Mineral-insulated, metal-sheathed cable, Type MI
- (15) Flexible metal conduit (FMC) not over 1.8 m (6 ft) long or liquidtight flexible metal conduit (LFMC) not over 1.8 m (6 ft) long between a raceway, or between a raceway and service equipment, with a supply-side bonding jumper routed with the flexible metal conduit (FMC) or the liquidtight flexible metal conduit (LFMC) according to 250.102(A), (B), (C), and (E)
- (16) Liquidtight flexible nonmetallic conduit (LFNC)
- (17) High density polyethylene conduit (HDPE)
- (18) Nonmetallic underground conduit with conductors (NUCC)
- (19) Reinforced thermosetting resin conduit (RTRC)
- (20) Type TC-ER cable where identified for use as service entrance conductors
- (21) Flexible bus systems

230.44 Cable Trays. Cable tray systems shall be permitted to support service-entrance conductors. Cable trays used to support service-entrance conductors shall contain only service-entrance conductors and shall be limited to the following methods:

- (1) Type SE cable
- (2) Type MC cable
- (3) Type MI cable
- (4) Type IGS cable
- (5) Single conductors 1/0 and larger that are listed for use in cable tray
- (6) Type TC-ER cable

Such cable trays shall be identified with permanently affixed labels with the wording "Service-Entrance Conductors." The labels shall be located so as to be visible after installation with a spacing not to exceed 3 m (10 ft) so that the service-entrance conductors are able to be readily traced through the entire length of the cable tray.

Exception: Conductors, other than service-entrance conductors, shall be permitted to be installed in a cable tray with service-entrance conductors, provided a solid fixed barrier identified for use with the cable tray is installed to separate the service-entrance conductors from other conductors installed in the cable tray.

230.46 Spliced and Tapped Conductors. Service-entrance conductors shall be permitted to be spliced or tapped in accordance with 110.14, 300.5(E), 300.13, and 300.15. Power distribution blocks, pressure connectors, and devices for splices and taps shall be listed. Power distribution blocks installed on service conductors shall be marked "suitable for use on the line side of the service equipment" or equivalent.

Pressure connectors and devices for splices and taps installed on service conductors shall be marked "suitable for use on the line side of the service equipment" or equivalent.

230.50 Protection Against Physical Damage.

(A) Underground Service-Entrance Conductors. Underground service-entrance conductors shall be protected against physical damage in accordance with 300.5.

(B) All Other Service-Entrance Conductors. All other service-entrance conductors, other than underground service entrance conductors, shall be protected against physical damage as specified in 230.50(B)(1) or (B)(2).

(1) Service-Entrance Cables. Service-entrance cables, where subject to physical damage, shall be protected by any of the following:

- (1) Rigid metal conduit (RMC)
- (2) Intermediate metal conduit (IMC)
- (3) Schedule 80 PVC conduit
- (4) Electrical metallic tubing (EMT)
- (5) Reinforced thermosetting resin conduit (RTRC)
- (6) Other approved means

(2) Other Than Service-Entrance Cables. Individual open conductors and cables, other than service-entrance cables, shall not be installed within 3.0 m (10 ft) of grade level or where exposed to physical damage.

Exception: Type MI and Type MC cable shall be permitted within 3.0 m (10 ft) of grade level where not exposed to physical damage or where protected in accordance with 300.5(D).

230.51 Mounting Supports. Service-entrance cables or individual open service-entrance conductors shall be supported as specified in 230.51(A), (B), or (C).

(A) Service-Entrance Cables. Service-entrance cables shall be supported by straps or other approved means within 300 mm (12 in.) of every service head, gooseneck, or connection to a raceway or enclosure and at intervals not exceeding 750 mm (30 in.).

(B) Other Cables. Cables that are not approved for mounting in contact with a building or other structure shall be mounted on insulating supports installed at intervals not exceeding 4.5 m (15 ft) and in a manner that maintains a clearance of not less than 50 mm (2 in.) from the surface over which they pass.

(C) Individual Open Conductors. Individual open conductors shall be installed in accordance with Table 230.51(C). Where exposed to the weather, the conductors shall be mounted on insulators or on insulating supports attached to racks, brackets, or other approved means. Where not exposed to the weather, the conductors shall be mounted on glass or porcelain knobs.

230.52 Individual Conductors Entering Buildings or Other Structures. Where individual open conductors enter a building or other structure, they shall enter through roof bushings or through the wall in an upward slant through individual,

noncombustible, nonabsorbent insulating tubes. Drip loops shall be formed on the conductors before they enter the tubes.

230.53 Raceways to Drain. Where exposed to the weather, raceways enclosing service-entrance conductors shall be listed or approved for use in wet locations and arranged to drain. Where embedded in masonry, raceways shall be arranged to drain.

230.54 Overhead Service Locations.

(A) Service Head. Service raceways shall be equipped with a service head at the point of connection to service-drop or overhead service conductors. The service head shall be listed for use in wet locations.

(B) Service-Entrance Cables Equipped with Service Head or Gooseneck. Service-entrance cables shall be equipped with a service head. The service head shall be listed for use in wet locations.

Exception: Type SE cable shall be permitted to be formed in a gooseneck and taped with a self-sealing weather-resistant thermoplastic.

(C) Service Heads and Goosenecks Above Service-Drop or Overhead Service Attachment. Service heads on raceways or service-entrance cables and goosenecks in service-entrance cables shall be located above the point of attachment of the service-drop or overhead service conductors to the building or other structure.

Exception: Where it is impracticable to locate the service head or gooseneck above the point of attachment, the service head or gooseneck location shall be permitted not farther than 600 mm (24 in.) from the point of attachment.

(D) Secured. Service-entrance cables shall be held securely in place.

(E) Separately Bushed Openings. Service heads shall have conductors of different potential brought out through separately bushed openings.

Exception: For jacketed multiconductor service-entrance cable without splice.

(F) Drip Loops. Drip loops shall be formed on individual conductors. To prevent the entrance of moisture, service-entrance conductors shall be connected to the service-drop or overhead service conductors either (1) below the level of the service head or (2) below the level of the termination of the service-entrance cable sheath.

(G) Arranged That Water Will Not Enter Service Raceway or Equipment. Service-entrance and overhead service conductors shall be arranged so that water will not enter service raceway or equipment.

230.56 Service Conductor with the Higher Voltage to Ground. On a 4-wire, delta-connected service where the midpoint of one phase winding is grounded, the service conductor having the higher phase voltage to ground shall be durably and permanently marked by an outer finish that is orange in color, or by other effective means, at each termination or junction point.

Table 230.51(C) Supports

Maximum Volts	Maximum Distance Between Supports		Minimum Clearance			
			Between Conductors		From Surface	
	m	ft	mm	in.	mm	in.
1000	2.7	9	150	6	50	2
1000	4.5	15	300	12	50	2
300	1.4	4½	75	3	50	2
1000*	1.4*	4½*	65*	2½*	25*	1*

*Where not exposed to weather.

Part V. Service Equipment — General

230.62 Service Equipment — Enclosed or Guarded. Energized parts of service equipment shall be enclosed as specified in 230.62(A) or guarded as specified in 230.62(B).

(A) Enclosed. Energized parts shall be enclosed so that they will not be exposed to accidental contact or shall be guarded as in 230.62(B).

(B) Guarded. Energized parts that are not enclosed shall be installed on a switchboard, panelboard, or control board and guarded in accordance with 110.18 and 110.27. Where energized parts are guarded as provided in 110.27(A)(1) and (A)(2), a means for locking or sealing doors providing access to energized parts shall be provided.

(C) Barriers. Barriers shall be placed in service equipment such that no uninsulated, ungrounded service busbar or service terminal is exposed to inadvertent contact by persons or maintenance equipment while servicing load terminations with the service disconnect in the open position.

230.66 Marking.

(A) General. Service equipment rated at 1000 volts or less shall be marked to identify it as being suitable for use as service equipment. All service equipment shall be listed or field evaluated.

(B) Meter Sockets. Meter sockets shall not be considered service equipment but shall be listed and rated for the voltage and current rating of the service.

Exception: Meter sockets supplied by and under the exclusive control of an electric utility shall not be required to be listed.

230.67 Surge Protection.

(A) Surge-Protective Device. All services supplying the following occupancies shall be provided with a surge-protective device (SPD):

- (1) Dwelling units
- (2) Dormitory units
- (3) Guest rooms and guest suites of hotels and motels
- (4) Areas of nursing homes and limited-care facilities used exclusively as patient sleeping rooms

Informational Note: See 517.10(B)(2).

Δ (B) Location. The SPD shall be an integral part of the service equipment or shall be located immediately adjacent thereto.

Exception: The SPD shall not be required to be located at the service equipment as required in 230.67(B) if located at each next level distribution equipment downstream toward the load.

(C) Type. The SPD shall be a Type 1 or Type 2 SPD.

(D) Replacement. Where service equipment is replaced, all of the requirements of this section shall apply.

■ (E) Ratings. SPDs shall have a nominal discharge current rating (In) of not less than 10kA.

Part VI. Service Equipment — Disconnecting Means

230.70 General. Means shall be provided to disconnect all ungrounded conductors in a building or other structure from the service conductors.

(A) Location. The service disconnecting means shall be installed in accordance with 230.70(A)(1), (A)(2), and (A)(3).

(1) Readily Accessible Location. The service disconnecting means shall be installed at a readily accessible location either outside of a building or structure or inside nearest the point of entrance of the service conductors.

(2) Bathrooms. Service disconnecting means shall not be installed in bathrooms.

(3) Remote Control. Where a remote control device(s) is used to actuate the service disconnecting means, the service disconnecting means shall be located in accordance with 230.70(A)(1).

(B) Marking. Each service disconnect shall be permanently marked to identify it as a service disconnect.

Δ (C) Suitable for Use. Each service disconnecting means shall be suitable for the prevailing conditions. Service equipment installed in hazardous (classified) locations shall comply with the hazardous location requirements.

230.71 Maximum Number of Disconnects. Each service shall have only one disconnecting means unless the requirements of 230.71(B) are met.

(A) General. For the purpose of this section, disconnecting means installed as part of listed equipment and used solely for the following shall not be considered a service disconnecting means:

- (1) Power monitoring equipment
- (2) Surge-protective device(s)
- (3) Control circuit of the ground-fault protection system
- (4) Power-operable service disconnecting means

Δ (B) Two to Six Service Disconnecting Means. Two to six service disconnects shall be permitted for each service permitted by 230.2 or for each set of service-entrance conductors permitted by 230.40, Exception No. 1, 3, 4, or 5. The two to six service disconnecting means shall be permitted to consist of a combination of any of the following:

- (1) Separate enclosures with a main service disconnecting means in each enclosure
- (2) Panelboards with a main service disconnecting means in each panelboard enclosure
- (3) Switchboard(s) where there is only one service disconnect in each separate vertical section with barriers provided between each vertical section to maintain the inadvertent contact protection required in 230.62 based on access from the adjacent section(s)
- (4) Service disconnects in switchgear, transfer switches, or metering centers where each disconnect is located in a separate compartment
- (5) Metering centers with a main service disconnecting means in each metering center
- (6) Motor control center(s) where there is only one service disconnect in a motor control center unit and a maximum of two service disconnects provided in a single motor control center with barriers provided between each motor control center unit or compartment containing a service disconnect to maintain the inadvertent contact protection required in 230.62 based on access from adjacent motor control center unit(s) or compartment(s)

Exception to (2), (3), (4), (5), and (6): Existing service equipment, installed in compliance with previous editions of this Code that permitted multiple service disconnecting means in a single enclosure, section, or compartment, shall be permitted to contain a maximum of six service disconnecting means.

Informational Note No. 1: See UL 67, *Standard for Panelboards*, for information on metering centers.

Informational Note No. 2: Examples of separate enclosures with a main service disconnecting means in each enclosure include but are not limited to motor control centers, fused disconnects, and circuit breaker enclosures.

Informational Note No. 3: Transfer switches are provided with one service disconnect or multiple service disconnects in separate compartments.

230.72 Grouping of Disconnects.

(A) General. The two to six disconnects, if permitted in 230.71, shall be grouped. Each disconnect shall be marked to indicate the load served.

Exception: One of the two to six service disconnecting means permitted in 230.71, where used only for a water pump also intended to provide fire protection, shall be permitted to be located remote from the other disconnecting means. If remotely installed in accordance with this exception, a plaque shall be posted at the location of the remaining grouped disconnects denoting its location.

(B) Additional Service Disconnecting Means. The one or more additional service disconnecting means for fire pumps, emergency systems, legally required standby, or optional standby services permitted by 230.2 shall be installed remote from the one to six service disconnecting means for normal service to minimize the possibility of simultaneous interruption of supply.

(C) Access to Occupants. In a multiple-occupancy building, each occupant shall have access to the occupant's service disconnecting means.

Exception: In a multiple-occupancy building where electric service and electrical maintenance are provided by the building management and where these are under continuous building management supervision, the service disconnecting means supplying more than one occupancy shall be permitted to be accessible to authorized management personnel only.

230.74 Simultaneous Opening of Poles. Each service disconnect shall simultaneously disconnect all ungrounded service conductors that it controls from the premises wiring system.

230.75 Disconnection of Grounded Conductor. Where the service disconnecting means does not disconnect the grounded conductor from the premises wiring, other means shall be provided for this purpose in the service equipment. A terminal or bus to which all grounded conductors can be attached by means of pressure connectors shall be permitted for this purpose. In a multisection switchboard or switchgear, disconnects for the grounded conductor shall be permitted to be in any section of the switchboard or switchgear, if the switchboard or switchgear section is marked to indicate a grounded conductor disconnect is located within.

Informational Note: In switchgear or multisection switchboards, the disconnecting means provided for the grounded conductor is typically identified as a neutral disconnect link and is typically located in the bus to which the service grounded conductor is connected.

230.76 Manually or Power Operable. The service disconnecting means for ungrounded service conductors shall consist of one of the following:

- (1) A manually operable switch or circuit breaker equipped with a handle or other suitable operating means
- (2) A power-operated switch or circuit breaker, provided the switch or circuit breaker can be opened by hand in the event of a power supply failure

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

230.79 Rating of Service Disconnecting Means. The service disconnecting means shall have a rating not less than the calculated load to be carried, determined in accordance with Part III, IV, or V of Article 220, as applicable. In no case shall the rating be lower than specified in 230.79(A), (B), (C), or (D).

(A) One-Circuit Installations. For installations to supply only limited loads of a single branch circuit, the service disconnecting means shall have a rating of not less than 15 amperes.

(B) Two-Circuit Installations. For installations consisting of not more than two 2-wire branch circuits, the service disconnecting means shall have a rating of not less than 30 amperes.

(C) One-Family Dwellings. For a one-family dwelling, the service disconnecting means shall have a rating of not less than 100 amperes, 3-wire.

(D) All Others. For all other installations, the service disconnecting means shall have a rating of not less than 60 amperes.

230.80 Combined Rating of Disconnects. Where the service disconnecting means consists of more than one switch or circuit breaker, as permitted by 230.71, the combined ratings of all the switches or circuit breakers used shall not be less than the rating required by 230.79.

230.81 Connection to Terminals. The service conductors shall be connected to the service disconnecting means by pressure connectors, clamps, or other approved means. Connections that depend on solder shall not be used.

▲ 230.82 Equipment Connected to the Supply Side of Service Disconnect. Only the following equipment shall be permitted to be connected to the supply side of the service disconnecting means:

- (1) Cable limiters.
- (2) Meters and meter sockets nominally rated not in excess of 1000 volts, if all metal housings and service enclosures are grounded in accordance with Part VII and bonded in accordance with Part V of Article 250.
- (3) Meter disconnect switches nominally rated not in excess of 1000 volts that have a short-circuit current rating equal to or greater than the available fault current, if all metal housings and service enclosures are grounded in accordance with Part VII and bonded in accordance with Part V of Article 250. A meter disconnect switch shall be capable of interrupting the load served. A meter disconnect shall be legibly field marked on its exterior in a manner suitable for the environment as follows:

METER DISCONNECT
NOT SERVICE EQUIPMENT

- (4) Instrument transformers (current and voltage), impedance shunts, load management devices, surge arresters, and Type 1 surge-protective devices.
- (5) Conductors used to supply **energy management systems**, circuits for standby power systems, fire pump equipment, and fire and sprinkler alarms, if provided with service equipment and installed in accordance with requirements for service-entrance conductors.
- (6) Solar photovoltaic systems, fuel cell systems, wind electric systems, energy storage systems, or interconnected electric power production sources, if provided with a disconnecting means listed as suitable for use as service equipment, and overcurrent protection as specified in Part VII of Article 230.
- (7) Control circuits for power-operable service disconnecting means, if suitable overcurrent protection and disconnecting means are provided.
- (8) Ground-fault protection systems or Type 2 surge-protective devices, where installed as part of listed equipment, if suitable overcurrent protection and disconnecting means are provided.
- (9) Connections used only to supply listed communications equipment under the exclusive control of the serving electric utility, if suitable overcurrent protection and disconnecting means are provided. For installations of equipment by the serving electric utility, a disconnecting means is not required if the supply is installed as part of a meter socket, such that access can only be gained with the meter removed.
- (10) Emergency disconnects in accordance with 230.85(B)(2) and (B)(3), if all metal housings and enclosures are grounded in accordance with Part VII and bonded in accordance with Part V of Article 250.
- (11) Meter-mounted transfer switches nominally rated not in excess of 1000 volts that have a short-circuit current rating equal to or greater than the available fault current. A meter-mounted transfer switch shall be listed and be capable of transferring the load served. A meter-mounted transfer switch shall be marked on its exterior with both of the following:
 - a. Meter-mounted transfer switch
 - b. Not service equipment
- (12) Control power circuits for protective relays where installed as part of listed equipment, if overcurrent protection and disconnecting means are provided.

Δ 230.85 Emergency Disconnects. For one- and two-family dwelling units, **an emergency disconnecting means shall be installed.**

N (A) General.

N (1) Location. The disconnecting means shall be installed in a readily accessible outdoor location on or within sight of the dwelling unit.

Exception: Where the requirements of 225.41 are met, this section shall not apply.

N (2) Rating. The disconnecting means shall have a short-circuit current rating equal to or greater than the available fault current.

N (3) Grouping. If more than one disconnecting means is provided, they shall be grouped.

N (B) Disconnects. Each disconnect shall be one of the following:

- (1) Service disconnect
- (2) A meter disconnect integral to the meter mounting equipment not marked as suitable only for use as service equipment installed in accordance with 230.82
- (3) Other listed disconnect switch or circuit breaker that is marked suitable for use as service equipment, but not marked as suitable only for use as service equipment, installed on the supply side of each service disconnect

Informational Note 1: Conductors between the emergency disconnect and the service disconnect in 230.85(2) and 230.85(3) are service conductors.

Informational Note 2: Equipment marked "Suitable only for use as service equipment" includes the factory marking "Service Disconnect".

N (C) Replacement. Where service equipment is replaced, all of the requirements of this section shall apply.

Exception: Where only meter sockets, service entrance conductors, or related raceways and fittings are replaced, the requirements of this section shall not apply.

N (D) Identification of Other Isolation Disconnects. Where equipment for isolation of other energy source systems is not located adjacent to the emergency disconnect required by this section, a plaque or directory identifying the location of all equipment for isolation of other energy sources shall be located adjacent to the disconnecting means required by this section.

Informational Note: See 445.18, 480.7, 705.20, and 706.15 for examples of other energy source system isolation means.

N (E) Marking.

N (1) Marking Text. The disconnecting means shall be marked as follows:

- (1) Service disconnect
- (2) Meter disconnects installed in accordance with 230.82(3) and marked as follows:

EMERGENCY DISCONNECT, METER DISCONNECT,
NOT SERVICE EQUIPMENT

- (3) Other listed disconnect switches or circuit breakers on the supply side of each service disconnect that are marked suitable for use as service equipment and marked as follows:

EMERGENCY DISCONNECT, NOT SERVICE EQUIPMENT

N (2) Marking Location and Size. Markings shall comply with 110.21(B) and both of the following:

- (1) The marking or labels shall be located on the outside front of the disconnect enclosure with red background and white text.
- (2) The letters shall be at least 13 mm (½ in.) high.

Part VII. Service Equipment — Overcurrent Protection

230.90 Where Required. Each ungrounded service conductor shall have overload protection.

Δ (A) Ungrounded Conductor. Such protection shall be provided by an overcurrent device in series with each ungrounded service conductor that has a rating or setting not higher than the ampacity of the conductor. A set of fuses shall be considered all the fuses required to protect all the ungrounded conductors of a circuit. Single-pole circuit breakers, grouped in accordance with 230.71(B), shall be considered as one protective device.

Exception No. 1: For motor-starting currents, ratings that comply with 430.52, 430.62, and 430.63 shall be permitted.

Exception No. 2: Fuses and circuit breakers with a rating or setting that complies with 240.4(B) or (C) and 240.6 shall be permitted.

Exception No. 3: Two to six circuit breakers or sets of fuses shall be permitted as the overcurrent device to provide the overload protection. The sum of the ratings of the circuit breakers or fuses shall be permitted to exceed the ampacity of the service conductors, provided the calculated load does not exceed the ampacity of the service conductors.

Exception No. 4: Overload protection for fire pump supply conductors shall comply with 695.4(B)(2)(a).

Exception No. 5: Overload protection in accordance with the conductor ampacities of 310.12 shall be permitted for single-phase dwelling services.

(B) Not in Grounded Conductor. No overcurrent device shall be inserted in a grounded service conductor except a circuit breaker that simultaneously opens all conductors of the circuit.

230.91 Location. The service overcurrent device shall be an integral part of the service disconnecting means or shall be located immediately adjacent thereto. Where fuses are used as the service overcurrent device, the disconnecting means shall be located ahead of the supply side of the fuses.

230.92 Locked Service Overcurrent Devices. Where the service overcurrent devices are locked or sealed or are not readily accessible to the occupant, branch-circuit or feeder overcurrent devices shall be installed on the load side, shall be mounted in a readily accessible location, and shall be of lower ampere rating than the service overcurrent device.

230.93 Protection of Specific Circuits. Where necessary to prevent tampering, an automatic overcurrent device that protects service conductors supplying only a specific load, such as a water heater, shall be permitted to be locked or sealed where located so as to be accessible.

230.94 Relative Location of Overcurrent Device and Other Service Equipment. The overcurrent device shall protect all circuits and devices.

Exception No. 1: The service switch shall be permitted on the supply side.

Exception No. 2: High-impedance shunt circuits, surge arresters, Type 1 surge-protective devices, surge-protective capacitors, and instrument transformers (current and voltage) shall be permitted to be connected and installed on the supply side of the service disconnecting means as permitted by 230.82.

Exception No. 3: Circuits for load management devices shall be permitted to be connected on the supply side of the service overcurrent device where separately provided with overcurrent protection.

Exception No. 4: Circuits used only for the operation of fire alarm, other protective signaling systems, or the supply to fire pump equipment shall

be permitted to be connected on the supply side of the service overcurrent device where separately provided with overcurrent protection.

Exception No. 5: Meters nominally rated not in excess of 600 volts shall be permitted, provided all metal housings and service enclosures are grounded.

Exception No. 6: Where service equipment is power operable, the control circuit shall be permitted to be connected ahead of the service equipment if suitable overcurrent protection and disconnecting means are provided.

230.95 Ground-Fault Protection of Equipment. Ground-fault protection of equipment shall be provided for solidly grounded wye electric services of more than 150 volts to ground but not exceeding 1000 volts phase-to-phase for each service disconnect rated 1000 amperes or more. The grounded conductor for the solidly grounded wye system shall be connected directly to ground through a grounding electrode system, as specified in 250.50, without inserting any resistor or impedance device.

The rating of the service disconnect shall be considered to be the rating of the largest fuse that can be installed or the highest continuous current trip setting for which the actual overcurrent device installed in a circuit breaker is rated or can be adjusted.

Exception: The ground-fault protection provisions of this section shall not apply to a service disconnect for a continuous industrial process where a nonorderly shutdown will introduce additional or increased hazards.

(A) Setting. The ground-fault protection system shall operate to cause the service disconnect to open all ungrounded conductors of the faulted circuit. The maximum setting of the ground-fault protection shall be 1200 amperes, and the maximum time delay shall be one second for ground-fault currents equal to or greater than 3000 amperes.

(B) Fuses. If a switch and fuse combination is used, the fuses employed shall be capable of interrupting any current higher than the interrupting capacity of the switch during a time that the ground-fault protective system will not cause the switch to open.

(C) Performance Testing. The ground-fault protection system shall be performance tested when first installed on site. This testing shall be conducted by a qualified person(s) using a test process of primary current injection, in accordance with instructions that shall be provided with the equipment. A written record of this testing shall be made and shall be available to the authority having jurisdiction.

Informational Note No. 1: Ground-fault protection that functions to open the service disconnect affords no protection from faults on the line side of the protective element. It serves only to limit damage to conductors and equipment on the load side in the event of an arcing ground fault on the load side of the protective element.

Informational Note No. 2: This added protective equipment at the service equipment **could** make it necessary to review the overall wiring system for proper selective overcurrent protection coordination. Additional installations of ground-fault protective equipment **might** be needed on feeders and branch circuits where maximum continuity of electric service is necessary.

Informational Note No. 3: Where ground-fault protection is provided for the service disconnect and interconnection is made with another supply system by a transfer device, means or devi-

ces **could** be needed to ensure proper ground-fault sensing by the ground-fault protection equipment.

Informational Note No. 4: See 517.17(A) for information on where an additional step of ground-fault protection is required for hospitals and other buildings with critical areas or life support equipment.

N

ARTICLE 235

Branch Circuits, Feeders, and Services Over 1000 Volts ac, 1500 Volts dc, Nominal

N Part I. General

N 235.1 Scope. This article provides the general requirements for branch circuits, feeders, and services over 1000 volts ac or 1500 volts dc, nominal.

Informational Note: See ANSI/IEEE C2-2017, *National Electrical Safety Code*, for additional information on wiring over 1000 volts, nominal.

N Part II. Branch Circuits

N 235.3 Other Articles for Specific-Purpose Branch Circuits.

Table 235.3 lists references for specific equipment and applications not located in Chapters 5, 6, and 7 that amend or supplement the requirements of this article.

N 235.5 Conductor Identification for Branch Circuits.

N (A) Grounded Conductor. The grounded conductor of a branch circuit shall be identified in accordance with 200.6.

N (B) Equipment Grounding Conductor. The equipment grounding conductor shall be identified in accordance with 250.119.

N Table 235.3 References for Specific Equipment and Applications Not Located in Chapters 5, 6, and 7

Equipment	Article	Section
Air-conditioning and refrigerating equipment		440.6, 440.31, and 440.32
Busways		368.17
Central heating equipment other than fixed electric space-heating equipment		422.12
Fixed electric heating equipment for pipelines and vessels		427.4
Fixed electric space-heating equipment		424.4
Fixed outdoor electrical deicing and snow-melting equipment		426.4
Infrared lamp industrial heating equipment		422.48 and 424.3
Motors, motor circuits, and controllers	430	

N (C) Ungrounded Conductors. Ungrounded conductors shall be identified in accordance with 235.5(C)(1) or (C)(2), as applicable.

N (1) Branch Circuits Supplied from More Than One Nominal Voltage System. Where the premises wiring system has branch circuits supplied from more than one nominal voltage system, each ungrounded conductor of a branch circuit shall be identified by phase or line and by nominal system voltage at all termination, connection, and splice points in accordance with 235.5(C)(1)(a) and (C)(1)(b). Different systems within the same premises that have the same nominal voltage shall be permitted to use the same identification.

(a) *Means of Identification.* The means of identification shall be permitted to be by separate color coding, marking tape, tagging, or other approved means.

(b) *Posting of Identification Means.* The method used for conductors originating within each branch-circuit panelboard or similar branch-circuit distribution equipment shall be documented in a manner that is readily available or shall be permanently posted at each branch-circuit panelboard or similar branch-circuit distribution equipment. The label shall be of sufficient durability to withstand the environment involved and shall not be handwritten.

Exception: In existing installations where a voltage system(s) already exists and a different voltage system is being added, it shall be permissible to mark only the new system voltage. Existing unidentified systems shall not be required to be identified at each termination, connection, and splice point in accordance with 235.5(C)(1)(a) and (C)(1)(b). Labeling shall be required at each voltage system distribution equipment to identify that only one voltage system has been marked for a new system(s). The new system label(s) shall include the words "other unidentified systems exist on the premises."

N (2) Branch Circuits Supplied from Direct-Current Systems.

Where a branch circuit is supplied from a dc system operating at more than 1500 volts, each ungrounded conductor of 4 AWG or larger shall be identified by polarity at all termination, connection, and splice points by marking tape, tagging, or other approved means and each ungrounded conductor of 6 AWG or smaller shall be identified by polarity at all termination, connection, and splice points in compliance with 235.5(C)(2)(a) and (C)(2)(b). The identification methods used for conductors originating within each branch-circuit panelboard or similar branch-circuit distribution equipment shall be documented in a manner that is readily available or be permanently posted at each branch-circuit panelboard or similar branch-circuit distribution equipment.

(a) *Positive Polarity, Sizes 6 AWG or Smaller.* Where the positive polarity of a dc system does not serve as the connection point for the grounded conductor, each positive ungrounded conductor shall be identified by one of the following means:

- (1) A continuous red outer finish
- (2) A continuous red stripe durably marked along the conductor's entire length on insulation of a color other than green, white, gray, or black
- (3) Imprinted plus signs (+) or the word POSITIVE or POS durably marked on insulation of a color other than green, white, gray, or black and repeated at intervals not exceeding 610 mm (24 in.) in accordance with 310.8(B)
- (4) An approved permanent marking means such as sleeving or shrink-tubing that is suitable for the conductor size, at all termination, connection, and splice points, with imprinted plus signs (+) or the word POSITIVE or POS

durably marked on insulation of a color other than green, white, gray, or black

(b) *Negative Polarity, Sizes 6 AWG or Smaller.* Where the negative polarity of a dc system does not serve as the connection point for the grounded conductor, each negative ungrounded conductor shall be identified by one of the following means:

- (1) A continuous black outer finish
- (2) A continuous black stripe durably marked along the conductor's entire length on insulation of a color other than green, white, gray, or red
- (3) Imprinted minus signs (–) or the word NEGATIVE or NEG durably marked on insulation of a color other than green, white, gray, or red and repeated at intervals not exceeding 610 mm (24 in.) in accordance with 310.8(B)
- (4) An approved permanent marking means such as sleeving or shrink-tubing that is suitable for the conductor size, at all termination, connection, and splice points, with imprinted minus signs (–) or the word NEGATIVE or NEG durably marked on insulation of a color other than green, white, gray, or red

N 235.6 Branch-Circuit Voltage Limitations Over 1000 volts ac or 1500 volts dc, Nominal, Between Conductors. Circuits exceeding 1000 volts ac or 1500 volts dc, nominal, between conductors shall be permitted to supply utilization equipment in installations where conditions of maintenance and supervision ensure that only qualified persons service the installation.

N 235.9 Circuits Derived from Autotransformers. Branch circuits shall not be derived from autotransformers unless the circuit supplied has a grounded conductor that is electrically connected to a grounded conductor of the system supplying the autotransformer.

N 235.10 Ungrounded Conductors Tapped from Grounded Systems. Two-wire dc circuits and ac circuits of two or more ungrounded conductors shall be permitted to be tapped from the ungrounded conductors of circuits that have a grounded neutral conductor. Switching devices in each tapped circuit shall have a pole in each ungrounded conductor. All poles of multiple switching devices shall manually switch together where such switching devices also serve as a disconnecting means as required by the following sections:

- (1) 410.93 for double-pole switched lampholders
- (2) 410.104(B) for electric-discharge lamp auxiliary equipment switching devices
- (3) 422.31(B) for an appliance
- (4) 424.20 for a fixed electric space-heating unit
- (5) 426.51 for electric deicing and snow-melting equipment
- (6) 430.85 for a motor controller
- (7) 430.103 for a motor

N 235.11 Branch Circuits Required. The minimum number of branch circuits shall be determined from the total calculated load and the size or rating of the circuits used. In all installations, the number of circuits shall be sufficient to supply the load served.

N 235.18 Rating. Branch circuits recognized by this article shall be rated in accordance with the maximum permitted ampere rating or setting of the overcurrent device. Where conductors of higher ampacity are used for any reason, the ampere rating or setting of the specified overcurrent device shall determine the circuit rating.

N 235.19 Conductors — Minimum Ampacity and Size. The ampacity of conductors shall be in accordance with 310.14 and 315.60, as applicable. Branch-circuit conductors shall be sized in accordance with 235.19(A) or (B).

N (A) General. The ampacity of branch-circuit conductors shall not be less than 125 percent of the designed potential load of utilization equipment that will be operated simultaneously.

N (B) Supervised Installations. For supervised installations, branch-circuit conductor sizing shall be permitted to be determined by qualified persons under engineering supervision. Supervised installations are defined as those portions of a facility where both of the following conditions are met:

- (1) Conditions of design and installation are provided under engineering supervision.
- (2) Qualified persons with documented training and experience in over 1000-volt ac or 1500-volt dc systems provide maintenance, monitoring, and servicing of the system.

N 235.20 Overcurrent Protection. Branch-circuit conductors and equipment shall be protected by overcurrent protective devices that have a rating or setting that complies with 235.20(A) through (C).

N (A) Continuous and Noncontinuous Loads. Where a branch circuit supplies continuous loads or any combination of continuous and noncontinuous loads, the rating of the overcurrent device shall not be less than the noncontinuous load plus 125 percent of the continuous load.

Exception: Where the assembly, including the overcurrent devices protecting the branch circuit(s), is listed for operation at 100 percent of its rating, the ampere rating of the overcurrent device shall be permitted to be not less than the sum of the continuous load plus the noncontinuous load.

N (B) Conductor Protection. Conductors shall be protected in accordance with the ampacities specified in 310.14 or 315.60, as applicable.

N (C) Equipment. The rating or setting of the overcurrent protective device shall not exceed that specified in the applicable articles referenced in Table 240.3 for equipment.

N 235.22 Permissible Loads, Individual Branch Circuits. An individual branch circuit shall be permitted to supply any load for which it is rated, but in no case shall the load exceed the branch-circuit ampere rating.

N 235.23 Permissible Loads, Multiple-Outlet Branch Circuits. A branch circuit supplying two or more outlets or receptacles shall supply only the loads specified according to its size in accordance with 210.23(A) through (E) and as summarized in 210.24, and in no case shall the load exceed the branch-circuit ampere rating.

N (A) 15- and 20-Ampere Branch Circuits. A 15- or 20-ampere branch circuit shall be permitted to supply lighting outlets, lighting units, or other utilization equipment, or any combination of them, and shall comply with 235.23(A)(1) and (A)(2).

N (1) Cord-and-Plug-Connected Equipment Not Fastened in Place. The rating of any one cord-and-plug-connected utilization equipment not fastened in place shall not exceed 80 percent of the branch-circuit ampere rating.

N (2) Utilization Equipment Fastened in Place. The total rating of utilization equipment fastened in place, other than lumin-

aires, shall not exceed 50 percent of the branch-circuit ampere rating where lighting units, cord-and-plug-connected utilization equipment not fastened in place, or both, are also supplied.

(B) 30-Ampere Branch Circuits. A 30-ampere branch circuit shall be permitted to supply fixed lighting units with heavy-duty lampholders in other than a dwelling unit(s) or utilization equipment in any occupancy. The rating of any one cord-and-plug-connected utilization equipment shall not exceed 80 percent of the branch-circuit ampere rating.

(C) 40- and 50-Ampere Branch Circuits. A 40- or 50-ampere branch circuit shall be permitted to supply cooking appliances that are fastened in place in any occupancy. In other than dwelling units, such circuits shall be permitted to supply fixed lighting units with heavy-duty lampholders, infrared heating units, or other utilization equipment.

(D) Branch Circuits Larger Than 50 Amperes. Branch circuits larger than 50 amperes shall supply only nonlighting outlet loads.

235.63 Equipment Requiring Servicing. A 125-volt, single-phase, 15- or 20-ampere-rated receptacle outlet shall be installed at an accessible location within 7.5 m (25 ft) of the equipment as specified in 210.63(A) and (B).

Informational Note: See 210.8(E) for requirements on GFCI protection.

(A) Heating, Air-Conditioning, and Refrigeration Equipment. The required receptacle outlet shall be located on the same level as the heating, air-conditioning, and refrigeration equipment. The receptacle outlet shall not be connected to the load side of the equipment's branch-circuit disconnecting means.

Exception: A receptacle outlet shall not be required at one- and two-family dwellings for the service of evaporative coolers.

(B) Other Electrical Equipment. In other than one- and two-family dwellings, a receptacle outlet shall be located as specified in 210.63(B)(1) and (B)(2).

(1) Indoor Service Equipment. The required receptacle outlet shall be located within the same room or area as the service equipment.

(2) Indoor Equipment Requiring Dedicated Equipment Spaces. Where equipment, other than service equipment, requires dedicated equipment space as specified in 110.26(E), the required receptacle outlet shall be located within the same room or area as the electrical equipment and shall not be connected to the load side of the equipment's disconnecting means.

Part III. Feeders

235.201 General. Part III covers the installation requirements, overcurrent protection requirements, minimum size, and ampacity of conductors for feeders over 1000 volts ac or 1500 volts dc, nominal.

235.202 Minimum Rating and Size. The ampacity of conductors shall be in accordance with 310.14 and 315.60 as applicable. Where installed, the size of the feeder-circuit grounded conductor shall not be smaller than that required by 250.122, except that 250.122(F) shall not apply where grounded conductors are run in parallel. Feeder conductors over

1000 volts shall be sized in accordance with 235.202(A), (B), or (C).

(A) Feeders Supplying Transformers. The ampacity of feeder conductors shall not be less than the sum of the nameplate ratings of the transformers supplied when only transformers are supplied.

(B) Feeders Supplying Transformers and Utilization Equipment. The ampacity of feeders supplying a combination of transformers and utilization equipment shall not be less than the sum of the nameplate ratings of the transformers and 125 percent of the designed potential load of the utilization equipment that will be operated simultaneously.

(C) Supervised Installations. For supervised installations, feeder conductor sizing shall be permitted to be determined by qualified persons under engineering supervision in accordance with 310.14(B) or 315.60(B). Supervised installations are defined as those portions of a facility where all of the following conditions are met:

- (1) Conditions of design and installation are provided under engineering supervision.
- (2) Qualified persons with documented training and experience in over 1000-volt systems provide maintenance, monitoring, and servicing of the system.

235.203 Overcurrent Protection. Feeders shall be protected against overcurrent.

235.205 Diagrams of Feeders. If required by the authority having jurisdiction, a diagram showing feeder details shall be provided prior to the installation of the feeders. Such a diagram shall show the area in square feet of the building or other structure supplied by each feeder, the total calculated load before applying demand factors, the demand factors used, the calculated load after applying demand factors, and the size and type of conductors to be used.

235.206 Feeder Equipment Grounding Conductor. Where a feeder supplies branch circuits in which equipment grounding conductors are required, the feeder shall include or provide an equipment grounding conductor, to which the equipment grounding conductors of the branch circuits shall be connected. Where the feeder supplies a separate building or structure, the requirements of 250.32 shall apply.

235.212 Identification for Feeders.

(A) Grounded Conductor. The grounded conductor of a feeder, if insulated, shall be identified in accordance with 200.6.

(B) Equipment Grounding Conductor. The equipment grounding conductor shall be identified in accordance with 250.119.

(C) Identification of Ungrounded Conductors. Ungrounded conductors shall be identified in accordance with 235.212(C)(1) or (C)(2), as applicable.

(1) Feeders Supplied from More Than One Nominal Voltage System. Where the premises wiring system has feeders supplied from more than one nominal voltage system, each ungrounded conductor of a feeder shall be identified by phase or line and system at all termination, connection, and splice points in compliance with 235.212(C)(1)(a) and (C)(1)(b).

(a) *Means of Identification.* The means of identification shall be permitted to be by separate color coding, marking tape, tagging, or other approved means.

(b) *Posting of Identification Means.* The method utilized for conductors originating within each feeder panelboard or similar feeder distribution equipment shall be documented in a manner that is readily available or shall be permanently posted at each feeder panelboard or similar feeder distribution equipment.

N (2) Feeders Supplied from Direct-Current Systems. Where a feeder is supplied from a dc system operating at more than 1500 volts, each ungrounded conductor of 4 AWG or larger shall be identified by polarity at all termination, connection, and splice points by marking tape, tagging, or other approved means; each ungrounded conductor of 6 AWG or smaller shall be identified by polarity at all termination, connection, and splice points in compliance with 235.212(C)(2)(a) and (C)(2)(b). The identification methods utilized for conductors originating within each feeder panelboard or similar feeder distribution equipment shall be documented in a manner that is readily available or shall be permanently posted at each feeder panelboard or similar feeder distribution equipment.

(a) *Positive Polarity, Sizes 6 AWG or Smaller.* Where the positive polarity of a dc system does not serve as the connection for the grounded conductor, each positive ungrounded conductor shall be identified by one of the following means:

- (1) A continuous red outer finish
- (2) A continuous red stripe durably marked along the conductor's entire length on insulation of a color other than green, white, gray, or black
- (3) Imprinted plus signs (+) or the word POSITIVE or POS durably marked on insulation of a color other than green, white, gray, or black, and repeated at intervals not exceeding 610 mm (24 in.) in accordance with 310.8(B)
- (4) An approved permanent marking means such as sleeving or shrink-tubing that is suitable for the conductor size, at all termination, connection, and splice points, with imprinted plus signs (+) or the word POSITIVE or POS durably marked on insulation of a color other than green, white, gray, or black

(b) *Negative Polarity, Sizes 6 AWG or Smaller.* Where the negative polarity of a dc system does not serve as the connection for the grounded conductor, each negative ungrounded conductor shall be identified by one of the following means:

- (1) A continuous black outer finish
- (2) A continuous black stripe durably marked along the conductor's entire length on insulation of a color other than green, white, gray, or red
- (3) Imprinted minus signs (–) or the word NEGATIVE or NEG durably marked on insulation of a color other than green, white, gray, or red, and repeated at intervals not exceeding 610 mm (24 in.) in accordance with 310.8(B)
- (4) An approved permanent marking means such as sleeving or shrink-tubing that is suitable for the conductor size, at all termination, connection, and splice points, with imprinted minus signs (–) or the word NEGATIVE or NEG durably marked on insulation of a color other than green, white, gray, or red

N Part IV. Outside Branch Circuits and Feeders

N 235.301 General. Part IV covers requirements for outside branch circuits and feeders over 1000 volts ac or 1500 volts dc,

nominal, that are run on or between buildings, structures, or poles on the premises; and electrical equipment and wiring for the supply of utilization equipment that is located on or attached to the outside of buildings, structures, or poles. Outside branch circuits and feeders over 1000 volts ac or 1500 volts dc, nominal, shall comply with the applicable requirements in Parts I and II of Article 225 and with Part IV of this article, which supplements or modifies those requirements.

N 235.306 Conductor Size and Support. For overhead spans, open individual conductors shall not be smaller than 6 AWG copper or 4 AWG aluminum where open individual conductors and 8 AWG copper or 6 AWG aluminum where in cable.

N 235.310 Wiring on Buildings (or Other Structures). The installation of outside wiring on surfaces of buildings (or other structures) shall be installed as provided in 305.3.

N 235.314 Open-Conductor Spacings. Conductors shall comply with the spacings provided in 110.36 and 495.24.

N 235.339 Rating of Disconnect. The feeder or branch-circuit disconnecting means shall have a rating of not less than the calculated load to be supplied, determined in accordance with Parts I and II of Article 220 for branch circuits, Part III or IV of Article 220 for feeders, or Part V of Article 220 for farm loads.

N 235.350 Sizing of Conductors. The sizing of conductors over 1000 volts shall be in accordance with 235.19(A) for branch circuits and 235.19(B) for feeders.

N 235.351 Isolating Switches. Where oil switches or air, oil, vacuum, or sulfur hexafluoride circuit breakers constitute a building disconnecting means, an isolating switch with visible break contacts and meeting the requirements of 235.404(B), (C), and (D) shall be installed on the supply side of the disconnecting means and all associated equipment.

Exception: The isolating switch shall not be required where the disconnecting means is mounted on removable truck panels or switchgear units that cannot be opened unless the circuit is disconnected and that, when removed from the normal operating position, automatically disconnect the circuit breaker or switch from all energized parts.

N 235.352 Disconnecting Means.

N (A) Location. A building or structure disconnecting means shall be located in accordance with 225.31(B), or, if not readily accessible, it shall be operable by mechanical linkage from a readily accessible point. For multibuilding industrial installations under single management, it shall be permitted to be electrically operated by a readily accessible, remote-control device in a separate building or structure.

N (B) Type. Each building or structure disconnect shall simultaneously disconnect all ungrounded supply conductors it controls and shall have a fault-closing rating not less than the available fault current at its supply terminals.

Exception: Where the individual disconnecting means consists of fused cutouts, the simultaneous disconnection of all ungrounded supply conductors shall not be required if there is a means to disconnect the load before opening the cutouts. A permanent legible sign shall be installed adjacent to the fused cutouts and shall read DISCONNECT LOAD BEFORE OPENING CUTOUTS.

Where fused switches or separately mounted fuses are installed, the fuse characteristics shall be permitted to contribute to the fault-closing rating of the disconnecting means.

(C) Locking. Disconnecting means shall be lockable open in accordance with 110.25.

Exception: Where an individual disconnecting means consists of fused cutouts, a suitable enclosure capable of being locked and sized to contain all cutout fuse holders shall be installed at a convenient location to the fused cutouts.

(D) Indicating. Disconnecting means shall clearly indicate whether they are in the open “off” or closed “on” position.

(E) Uniform Position. Where disconnecting means handles are operated vertically, the “up” position of the handle shall be the “on” position.

Exception: A switching device having more than one “on” position, such as a double throw switch, shall not be required to comply with this requirement.

(F) Identification. Where a building or structure has any combination of feeders, branch circuits, or services passing through or supplying it, a permanent plaque or directory shall be installed at each feeder and branch-circuit disconnect location that denotes all other services, feeders, or branch circuits supplying that building or structure or passing through that building or structure and the area served by each.

235.356 Inspections and Tests.

(A) Pre-Energization and Operating Tests. The complete electrical system design, including settings for protective, switching, and control circuits, shall be prepared in advance and made available on request to the authority having jurisdiction and shall be performance tested when first installed on-site. Each protective, switching, and control circuit shall be adjusted in accordance with the system design and tested by actual operation using current injection or equivalent methods as necessary to ensure that each and every such circuit operates correctly to the satisfaction of the authority having jurisdiction.

(1) Instrument Transformers. All instrument transformers shall be tested to verify correct polarity and burden.

(2) Protective Relays. Each protective relay shall be demonstrated to operate by injecting current or voltage, or both, at the associated instrument transformer output terminal and observing that the associated switching and signaling functions occur correctly and in proper time and sequence to accomplish the protective function intended.

(3) Switching Circuits. Each switching circuit shall be observed to operate the associated equipment being switched.

(4) Control and Signal Circuits. Each control or signal circuit shall be observed to perform its proper control function or produce a correct signal output.

(5) Metering Circuits. All metering circuits shall be verified to operate correctly from voltage and current sources in a similar manner to protective relay circuits.

(6) Acceptance Tests. Complete acceptance tests shall be performed, after the substation installation is completed, on all assemblies, equipment, conductors, and control and protective systems, as applicable, to verify the integrity of all the systems.

(7) Relays and Metering Utilizing Phase Differences. All relays and metering that use phase differences for operation shall be verified by measuring phase angles at the relay under actual load conditions after operation commences.

(B) Test Report. A test report covering the results of the tests required in 235.356(A) shall be delivered to the authority having jurisdiction prior to energization.

Informational Note: See ANSI/NETA ATS, *Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems*, for an example of acceptance specifications.

235.360 Clearances over Roadways, Walkways, Rail, Water, and Open Land.

(A) 22 kV or Less to Ground. The clearances over roadways, walkways, rail, water, and open land for conductors and live parts up to 22 kV or less to ground shall be not less than the values shown in Table 235.360(A).

(B) More Than 22 kV to Ground. Clearances for the categories shown in Table 235.360(A) shall be increased by 10 mm (0.4 in.) per kV, or major fraction thereof, more than 22 kV.

(C) Special Cases. For special cases, such as where crossings will be made over lakes, rivers, or areas using large vehicles such as mining operations, specific designs shall be engineered considering the special circumstances and shall be approved by the authority having jurisdiction.

Informational Note: See ANSI/IEEE C2-2017, *National Electrical Safety Code*, for additional information.

235.361 Clearances over Buildings and Other Structures.

(A) 22 kV or Less to Ground. The clearances over buildings and other structures for conductors and live parts up to 22 kV or less to ground shall be not less than the values shown in Table 235.361(A).

(B) More Than 22 kV to Ground. Clearances for the categories shown in Table 235.361(A) shall be increased by 10 mm (0.4 in.) per kV, or major fraction thereof, more than 22 kV.

Informational Note: See ANSI/IEEE C2-2017, *National Electrical Safety Code*, for additional information.

Part V. Services

235.401 General. Part V covers requirements for service conductors and equipment used on circuits over 1000 volts ac and 1500 volts dc, nominal, shall comply with all of the applicable requirements in Parts I through VII of Article 230 and with Part V of this article, which supplements or modifies those requirements. In no case shall the provisions of Part V apply to equipment on the supply side of the service point.

Table 235.360(A) Clearances over Roadways, Walkways, Rail, Water, and Open Land

Location	Clearance	
	m	ft
Open land subject to vehicles, cultivation, or grazing	5.6	18.5
Roadways, driveways, parking lots, and alleys	5.6	18.5
Walkways	4.1	13.5
Rails	8.1	26.5
Spaces and ways for pedestrians and restricted traffic	4.4	14.5
Water areas not suitable for boating	5.2	17.0

N Table 235.361(A) Clearances over Buildings and Other Structures

Clearance from Conductors or Live Parts from:	Horizontal		Vertical	
	m	ft	m	ft
Building walls, projections, and windows	2.3	7.5	—	—
Balconies, catwalks, and similar areas accessible to people	2.3	7.5	4.1	13.5
Over or under roofs or projections not readily accessible to people	—	—	3.8	12.5
Over roofs accessible to vehicles but not trucks	—	—	4.1	13.5
Over roofs accessible to trucks	—	—	5.6	18.5
Other structures	2.3	7.5	—	—

N 235.402 Service-Entrance Conductors. Service-entrance conductors to buildings or enclosures shall be installed to conform to 235.402(A) and (B).

N (A) Conductor Size. Service-entrance conductors shall not be smaller than 6 AWG unless in multiconductor cable. Multiconductor cable shall not be smaller than 8 AWG.

N (B) Wiring Methods. Service-entrance conductors shall be installed by one of the wiring methods covered in 305.3 and 305.15.

N 235.404 Isolating Switches.

N (A) Where Required. Where oil switches or air, oil, vacuum, or sulfur hexafluoride circuit breakers constitute the service disconnecting means, an isolating switch with visible break contacts shall be installed on the supply side of the disconnecting means and all associated service equipment.

Exception: An isolating switch shall not be required where the circuit breaker or switch is mounted on removable truck panels or switchgear units where both of the following conditions apply:

- (1) *Cannot be opened unless the circuit is disconnected*
- (2) *Where all energized parts are automatically disconnected when the circuit breaker or switch is removed from the normal operating position*

N (B) Fuses as Isolating Switch. Where fuses are of the type that can be operated as a disconnecting switch, a set of such fuses shall be permitted as the isolating switch.

N (C) Accessible to Qualified Persons Only. The isolating switch shall be accessible to qualified persons only.

N (D) Connection to Ground. Isolating switches shall be provided with a means for readily connecting the load side conductors to a grounding electrode system, equipment ground busbar, or grounded steel structure when disconnected from the source of supply.

A means for grounding the load side conductors to a grounding electrode system, equipment grounding busbar, or grounded structural steel shall not be required for any duplicate isolating switch installed and maintained by the electric supply company.

N 235.405 Disconnecting Means.

N (A) Location. The service disconnecting means shall be located in accordance with 230.70.

For either overhead or underground primary distribution systems on private property, the service disconnect shall be permitted to be located in a location that is not readily accessible, if the disconnecting means can be operated by mechanical linkage from a readily accessible point, or electronically in accordance with 235.405(C), where applicable.

N (B) Type. Each service disconnect shall simultaneously disconnect all ungrounded service conductors that it controls and shall have a fault-closing rating that is not less than the available fault current at its supply terminals.

Where fused switches or separately mounted fuses are installed, the fuse characteristics shall be permitted to contribute to the fault-closing rating of the disconnecting means.

N (C) Remote Control. For multibuilding, industrial installations under single management, the service disconnecting means shall be permitted to be located at a separate building or structure. In such cases, the service disconnecting means shall be permitted to be electrically operated by a readily accessible, remote-control device.

N 235.406 Overcurrent Devices as Disconnecting Means. Where the circuit breaker or alternative for it, as specified in 235.408 for service overcurrent devices, meets the requirements specified in 235.405, it shall constitute the service disconnecting means.

N 235.408 Protection Requirements. A short-circuit protective device shall be provided on the load side of, or as an integral part of, the service disconnect, and shall protect all ungrounded conductors that it supplies. The protective device shall be capable of detecting and interrupting all values of current, in excess of its trip setting or melting point, that can occur at its location. A fuse rated in continuous amperes not to exceed three times the ampacity of the conductor, or a circuit breaker with a trip setting of not more than six times the ampacity of the conductors, shall be considered as providing the required short-circuit protection.

Informational Note: See Table 315.60(C)(1) through Table 315.60(C)(20) for ampacities of conductors rated 2001 volts to 35,000 volts.

Overcurrent devices shall conform to 235.408(A) and (B).

N (A) Equipment Type. Equipment used to protect service-entrance conductors shall meet the requirements of Article 495, Part II.

N (B) Enclosed Overcurrent Devices. The restriction to 80 percent of the rating for an enclosed overcurrent device for continuous loads shall not apply to overcurrent devices installed in systems operating at over 1000 volts.

N 235.409 Surge Arresters. Surge arresters installed in accordance with the requirements of Parts II and III of Article 242 shall be permitted on each ungrounded overhead service conductor.

Informational Note: Surge arresters may be referred to as lightning arresters in older documents.

N 235.410 Service Equipment — General. Service equipment, including instrument transformers, shall conform to Part I of Article 495.

N 235.411 Switchgear. Switchgear shall consist of a substantial metal structure and a sheet metal enclosure. Where installed over a combustible floor, suitable protection thereto shall be provided.

N 235.412 Over 35,000 Volts. Where the voltage exceeds 35,000 volts between conductors that enter a building, they shall terminate in a switchgear compartment or a vault conforming to the requirements of 450.41 through 450.48.

ARTICLE 240 Overcurrent Protection

Part I. General

Δ 240.1 Scope. Parts I through VII of this article provide the general requirements for overcurrent protection and overcurrent protective devices not more than 1000 volts, nominal. Part VIII covers overcurrent protection for those portions of supervised industrial installations operating at voltages of not more than 1000 volts, nominal.

Informational Note No. 1: Overcurrent protection for conductors and equipment is provided to open the circuit if the current reaches a value that will cause an excessive or dangerous temperature in conductors or conductor insulation.

Informational Note No. 2: See 110.9 for requirements for interrupting ratings and 110.10 for requirements for protection against fault currents.

N 240.2 Reconditioned Equipment.

N (A) Reconditioning Not Permitted. The following equipment shall not be reconditioned:

- (1) Equipment providing ground-fault protection of equipment
- (2) Ground-fault circuit interrupters
- (3) Low-voltage fuseholders and low-voltage nonrenewable fuses
- (4) Molded-case circuit breakers
- (5) Low-voltage power circuit breaker electronic trip units.

N (B) Reconditioning Permitted. The following equipment shall be permitted to be reconditioned:

- (1) Low-voltage power circuit breakers
- (2) Electromechanical protective relays and current transformers

Reconditioned equipment shall be listed as reconditioned and comply with 110.21(A)(2).

240.3 Other Articles. Equipment shall be protected against overcurrent in accordance with the article in this *Code* that covers the type of equipment specified in Table 240.3.

240.4 Protection of Conductors. Conductors, other than flexible cords, flexible cables, and fixture wires, shall be protected against overcurrent in accordance with their ampacities speci-

Δ Table 240.3 Other Articles

Equipment	Article
Air-conditioning and refrigerating equipment	440
Appliances	422
Assembly occupancies	518
Audio signal processing, amplification, and reproduction equipment	640
Branch circuits	210
Busways	368
Capacitors	460
Class 1 power-limited circuits and Class 1 power-limited remote-control and signaling circuits	724
Class 2 and Class 3 remote-control, signaling, and power-limited circuits	725
Cranes and hoists	610
Electric signs and outline lighting	600
Electric welders	630
Electrolytic cells	668
Elevators, dumbwaiters, escalators, moving walks, wheelchair lifts, and stairway chairlifts	620
Emergency systems	700
Fire alarm systems	760
Fire pumps	695
Fixed electric heating equipment for pipelines and vessels	427
Fixed electric space-heating equipment	424
Fixed outdoor electric deicing and snow-melting equipment	426
Generators	445
Health care facilities	517
Induction and dielectric heating equipment	665
Industrial machinery	670
Luminaires, lampholders, and lamps	410
Motion picture and television studios and similar locations	530
Motors, motor circuits, and controllers	430
Phase converters	455
Pipe organs	650
Receptacles	406
Services	230
Solar photovoltaic systems	690
Switchboards, switchgear, and panelboards	408
Theaters, audience areas of motion picture and television studios, and similar locations	520
Transformers and transformer vaults	450
X-ray equipment	660

fied in 310.14, unless otherwise permitted or required in 240.4(A) through (H).

Informational Note: See ICEA P-32-382-2018, *Short Circuit Characteristics of Insulated Cables*, for information on allowable short-circuit currents for insulated copper and aluminum conductors.

(A) Power Loss Hazard. Conductor overload protection shall not be required where the interruption of the circuit would create a hazard, such as in a material-handling magnet circuit or fire pump circuit. Short-circuit protection shall be provided.

Informational Note: See NFPA 20-2019, *Standard for the Installation of Stationary Pumps for Fire Protection*.

(B) Overcurrent Devices Rated 800 Amperes or Less. The next higher standard overcurrent device rating (above the ampacity of the conductors being protected) shall be permitted to be used, provided all of the following conditions are met:

- (1) The conductors being protected are not part of a branch circuit supplying more than one receptacle for cord-and-plug-connected portable loads.
- (2) The ampacity of the conductors does not correspond with the standard ampere rating of a fuse or a circuit breaker without overload trip adjustments above its rating (but that shall be permitted to have other trip or rating adjustments).
- (3) The next higher standard rating selected does not exceed 800 amperes.

If the overcurrent protective device is an adjustable trip device installed in accordance with 240.4(B)(1), (B)(2), and (B)(3), it shall be permitted to be set to a value that does not exceed the next higher standard value above the ampacity of the conductors being protected as shown in Table 240.6(A) where restricted access in accordance with 240.6(C) is provided.

(C) Overcurrent Devices Rated over 800 Amperes. Where the overcurrent device is rated over 800 amperes, the ampacity of the conductors it protects shall be equal to or greater than the rating of the overcurrent device defined in 240.6.

(D) Small Conductors. Unless specifically permitted in 240.4(E) or (G), the overcurrent protection shall not exceed that required by 240.4(D)(1) through (D)(8) after any correction factors for ambient temperature and number of conductors have been applied.

(1) 18 AWG Copper. 7 amperes, provided all the following conditions are met:

- (1) Continuous loads do not exceed 5.6 amperes.
- (2) Overcurrent protection is provided by one of the following:
 - a. Branch-circuit-rated circuit breakers listed and marked for use with 18 AWG copper conductor
 - b. Branch-circuit-rated fuses listed and marked for use with 18 AWG copper conductor
 - c. Class CC, Class CF, Class J, or Class T fuses

(2) 16 AWG Copper. 10 amperes, provided all the following conditions are met:

- (1) Continuous loads do not exceed 8 amperes.
- (2) Overcurrent protection is provided by one of the following:
 - a. Branch-circuit-rated circuit breakers listed and marked for use with 16 AWG copper conductor
 - b. Branch-circuit-rated fuses listed and marked for use with 16 AWG copper conductor
 - c. Class CC, Class CF, Class J, or Class T fuses

N (3) 14 AWG Copper-Clad Aluminum. 10 amperes, provided all the following conditions are met:

- (1) Continuous loads do not exceed 8 amperes
- (2) Overcurrent protection is provided by one of the following:
 - a. Branch-circuit-rated circuit breakers are listed and marked for use with 14 AWG copper-clad aluminum conductor.

b. Branch-circuit-rated fuses are listed and marked for use with 14 AWG copper-clad aluminum conductor.

(4) 14 AWG Copper. 15 amperes

(5) 12 AWG Aluminum and Copper-Clad Aluminum. 15 amperes

(6) 12 AWG Copper. 20 amperes

(7) 10 AWG Aluminum and Copper-Clad Aluminum. 25 amperes

(8) 10 AWG Copper. 30 amperes

(E) Tap Conductors. Tap conductors shall be permitted to be protected against overcurrent in accordance with the following:

- (1) 210.19(C) and (D), Household Ranges and Cooking Appliances and Other Loads
- (2) 240.5(B)(2), Fixture Wire
- (3) 240.21, Location in Circuit
- (4) 368.17(B), Reduction in Ampacity Size of Busway
- (5) 368.17(C), Feeder or Branch Circuits (busway taps)
- (6) 430.53(D), Single Motor Taps

(F) Transformer Secondary Conductors. Single-phase (other than 2-wire) and multiphase (other than delta-delta, 3-wire) transformer secondary conductors shall not be considered to be protected by the primary overcurrent protective device. Conductors supplied by the secondary side of a single-phase transformer having a 2-wire (single-voltage) secondary, or a three-phase, delta-delta connected transformer having a 3-wire (single-voltage) secondary, shall be permitted to be protected by overcurrent protection provided on the primary (supply) side of the transformer, provided this protection is in accordance with 450.3 and does not exceed the value determined by multiplying the secondary conductor ampacity by the secondary-to-primary transformer voltage ratio.

(G) Overcurrent Protection for Specific Conductor Applications. Overcurrent protection for the specific conductors shall be permitted to be provided as referenced in Table 240.4(G).

N (H) Dwelling Unit Service and Feeder Conductors. Dwelling unit service and feeder conductors shall be permitted to be protected against overcurrent at the ampacity values in 310.12.

240.5 Protection of Flexible Cords, Flexible Cables, and Fixture Wires. Flexible cord and flexible cable, including tinsel cord and extension cords, and fixture wires shall be protected against overcurrent by either 240.5(A) or (B).

(A) Ampacities. Flexible cord and flexible cable shall be protected by an overcurrent device in accordance with their ampacity as specified in Table 400.5(A)(1) and Table 400.5(A)(2). Fixture wire shall be protected against overcurrent in accordance with its ampacity as specified in Table 402.5. Supplementary overcurrent protection, as covered in 240.10, shall be permitted to be an acceptable means for providing this protection.

(B) Branch-Circuit Overcurrent Device. Flexible cord shall be protected, where supplied by a branch circuit, in accordance with one of the methods described in 240.5(B)(1), (B)(3), or (B)(4). Fixture wire shall be protected, where supplied by a branch circuit, in accordance with 240.5(B)(2).

Table 240.4(G) Specific Conductor Applications

Conductor	Article	Section
Air-conditioning and refrigeration equipment circuit conductors	440, Parts III, IV, VI	
Capacitor circuit conductors	460	460.8(B) and 460.25
Control and instrumentation circuit conductors (Type ITC)	335	335.9
Electric welder circuit conductors	630	630.12 and 630.32
Fire alarm system circuit conductors	760	760.43, 760.45, 760.121, and Chapter 9, Tables 12(A) and 12(B)
Motor-operated appliance circuit conductors	422, Part II	
Motor and motor-control circuit conductors	430, Parts II, III, IV, V, VI, VII	
Phase converter supply conductors	455	455.7
Remote-control, signaling, and power-limited circuit conductors	725	724.43, 724.45, 725.60, and Chapter 9, Tables 11(A) and 11(B)
Secondary tie conductors	450	450.6

(1) Supply Cord of Listed Appliance or Luminaire. Where flexible cord or tinsel cord is approved for and used with a specific listed appliance or luminaire, it shall be considered to be protected when applied within the appliance or luminaire listing requirements. For the purposes of this section, a luminaire may be either portable or permanent.

(2) Fixture Wire. Fixture wire shall be permitted to be tapped to the branch-circuit conductor of a branch circuit in accordance with the following:

- (1) 15- or 20-ampere circuits — 18 AWG, up to 15 m (50 ft) of run length
- (2) 15- or 20-ampere circuits — 16 AWG, up to 30 m (100 ft) of run length
- (3) 20-ampere circuits — 14 AWG and larger
- (4) 30-ampere circuits — 14 AWG and larger
- (5) 40-ampere circuits — 12 AWG and larger
- (6) 50-ampere circuits — 12 AWG and larger

(3) Extension Cord Sets. Flexible cord used in listed extension cord sets shall be considered to be protected when applied within the extension cord listing requirements.

(4) Field Assembled Extension Cord Sets. Flexible cord used in extension cords made with separately listed and installed components shall be permitted to be supplied by a branch circuit in accordance with the following:

20-ampere circuits — 16 AWG and larger

240.6 Standard Ampere Ratings.

(A) Fuses and Fixed-Trip Circuit Breakers. The standard ampere ratings for fuses and inverse time circuit breakers shall be considered as shown in Table 240.6(A). Additional standard ampere ratings for fuses shall be 1, 3, 6, and 601. The use of fuses and inverse time circuit breakers with nonstandard ampere ratings shall be permitted.

Table 240.6(A) Standard Ampere Ratings for Fuses and Inverse Time Circuit Breakers

Standard Ampere Ratings				
10	15	20	25	30
35	40	45	50	60
70	80	90	100	110
125	150	175	200	225
250	300	350	400	450
500	600	700	800	1000
1200	1600	2000	2500	3000
4000	5000	6000	—	—

(B) Adjustable-Trip Circuit Breakers. The rating of adjustable-trip circuit breakers having external means for adjusting the current setting (long-time pickup setting), not meeting the requirements of 240.6(C), shall be the maximum setting possible.

(C) Local Restricted Access Adjustable-Trip Circuit Breakers. A circuit breaker(s) that has restricted access to the adjusting means shall be permitted to have an ampere rating(s) that is equal to the adjusted current setting (long-time pickup setting). Restricted access shall be achieved by one of the following methods:

- (1) Located behind removable and sealable covers over the adjusting means
- (2) Located behind bolted equipment enclosure doors
- (3) Located behind locked doors accessible only to qualified personnel
- (4) Password protected, with password accessible only to qualified personnel

Informational Note: See NFPA 730, *Guide for Premises Security*, and ANSI/TIA-5017, *Telecommunications Physical Network Security Standard*, for information regarding physical security.

(D) Remotely Accessible Adjustable-Trip Circuit Breakers. A circuit breaker(s) that can be adjusted remotely to modify the adjusting means shall be permitted to have an ampere rating(s) that is equal to the adjusted current setting (long-time pickup setting). Remote access shall be achieved by one of the following methods:

- (1) Connected directly through a local nonnetworked interface.
- (2) Connected through a networked interface complying with one of the following methods:
 - a. The circuit breaker and associated software for adjusting the settings are identified as being evaluated for cybersecurity.
 - b. A cybersecurity assessment of the network is completed. Documentation of the assessment and certification shall be made available to those authorized to inspect, operate, and maintain the system.

Informational Note No. 1: See ANSI/ISA 62443, *Cybersecurity Standards series*, UL 2900 *Cybersecurity Standard series*, or the NIST *Framework for Improving Critical Infrastructure Cybersecurity*, Version 1.1 for assessment requirements.

Informational Note No. 2: Examples of the commissioning certification used to demonstrate the system has been investigated for cybersecurity vulnerabilities could be one of the following:

- (1) The ISA Security Compliance Institute (ISCI) conformity assessment program
- (2) Certification of compliance by a nationally recognized test laboratory
- (3) Manufacturer certification for the specific type and brand of system provided

Informational Note No. 3: Cybersecurity is a specialized field requiring constant, vigilant attention to security vulnerabilities that could arise due to software defects, system configuration changes, or user interactions. Installation of devices that can be secured is an important first step but not sufficient to guarantee a secure system.

N 240.7 Listing Requirements. The following shall be listed:

- (1) Branch-circuit overcurrent protective devices
- (2) Relays and circuit breakers providing ground-fault protection of equipment
- (3) Ground-fault circuit interrupter devices

240.8 Fuses or Circuit Breakers in Parallel. Fuses and circuit breakers shall be permitted to be connected in parallel where they are factory assembled in parallel and listed as a unit. Individual fuses, circuit breakers, or combinations thereof shall not otherwise be connected in parallel.

240.9 Thermal Devices. Thermal relays and other devices not designed to open short circuits or ground faults shall not be used for the protection of conductors against overcurrent due to short circuits or ground faults, but the use of such devices shall be permitted to protect motor branch-circuit conductors from overload if protected in accordance with 430.40.

240.10 Supplementary Overcurrent Protection. Where supplementary overcurrent protection is used for luminaires, appliances, and other equipment or for internal circuits and components of equipment, it shall not be used as a substitute for required branch-circuit overcurrent devices or in place of the required branch-circuit protection. Supplementary overcurrent devices shall not be required to be readily accessible.

N 240.11 Selective Coordination. If one or more feeder overcurrent protective devices are required to be selectively coordinated with a service overcurrent protective device by other requirements in this *Code*, all feeder overcurrent protective devices supplied directly by the service overcurrent protective device shall be selectively coordinated with the service overcurrent protective device.

240.12 Orderly Shutdown. Where an orderly shutdown is required to minimize the hazard(s) to personnel or equipment, a system of coordination based on the following two conditions shall be permitted:

- (1) Coordinated short-circuit protection
- (2) Overload indication based on monitoring systems or devices

Informational Note: The monitoring system may cause the condition to go to alarm, allowing corrective action or an

orderly shutdown, thereby minimizing personnel hazard and equipment damage.

240.13 Ground-Fault Protection of Equipment. Ground-fault protection of equipment shall be provided in accordance with 230.95 for solidly grounded wye electrical systems of more than 150 volts to ground but not exceeding 1000 volts phase-to-phase for each individual device used as a building or structure main disconnecting means rated 1000 amperes or more.

This section shall not apply to the disconnecting means for the following:

- (1) Continuous industrial processes where a nonorderly shutdown will introduce additional or increased hazards
- (2) Installations where ground-fault protection is provided by other requirements for services or feeders
- (3) Fire pumps

240.15 Ungrounded Conductors.

(A) Overcurrent Device Required. A fuse or an overcurrent trip unit of a circuit breaker shall be connected in series with each ungrounded conductor. A combination of a current transformer and overcurrent relay shall be considered equivalent to an overcurrent trip unit.

Informational Note: See Parts III, IV, V, and XI of Article 430 for motor circuits.

(B) Circuit Breaker as Overcurrent Device. Circuit breakers shall open all ungrounded conductors of the circuit both manually and automatically unless otherwise permitted in 240.15(B)(1), (B)(2), (B)(3), and (B)(4).

(1) Multiwire Branch Circuits. Individual single-pole circuit breakers, with identified handle ties, shall be permitted as the protection for each ungrounded conductor of multiwire branch circuits that serve only single-phase line-to-neutral loads.

(2) Grounded Single-Phase Alternating-Current Circuits. In grounded systems, individual single-pole circuit breakers rated 120/240 volts ac, with identified handle ties, shall be permitted as the protection for each ungrounded conductor for line-to-line connected loads for single-phase circuits.

(3) 3-Phase and 2-Phase Systems. For line-to-line loads in 4-wire, 3-phase systems or 5-wire, 2-phase systems, individual single-pole circuit breakers rated 120/240 volts ac with identified handle ties shall be permitted as the protection for each ungrounded conductor, if the systems have a grounded neutral point and the voltage to ground does not exceed 120 volts.

(4) 3-Wire Direct-Current Circuits. Individual single-pole circuit breakers rated 125/250 volts dc with identified handle ties shall be permitted as the protection for each ungrounded conductor for line-to-line connected loads for 3-wire, direct-current circuits supplied from a system with a grounded neutral where the voltage to ground does not exceed 125 volts.

N 240.16 Interrupting Ratings. Branch-circuit overcurrent protective devices shall have an interrupting rating no less than 5000 amperes.

Part II. Location

240.21 Location in Circuit. Overcurrent protection shall be provided in each ungrounded circuit conductor and shall be

located at the point where the conductors receive their supply except as specified in 240.21(A) through (H). Conductors supplied under 240.21(A) through (H) shall not supply another conductor except through an overcurrent protective device meeting the requirements of 240.4.

(A) Branch-Circuit Conductors. Branch-circuit tap conductors meeting the requirements specified in 210.19 shall be permitted to have overcurrent protection as specified in 210.20.

(B) Feeder Taps. Conductors shall be permitted to be tapped, without overcurrent protection at the tap, to a feeder as specified in 240.21(B)(1) through (B)(5). The tap shall be permitted at any point on the load side of the feeder overcurrent protective device. Section 240.4(B) shall not be permitted for tap conductors.

Δ (1) Taps Not over 3 m (10 ft) Long. If the length of the tap conductors does not exceed 3 m (10 ft) and the tap conductors comply with all of the following:

- (1) The ampacity of the tap conductors is **as follows**:
 - a. Not less than the combined calculated loads on the circuits supplied by the tap conductors
 - b. Not less than the rating of the equipment containing an overcurrent device(s) supplied by the tap conductors or not less than the rating of the overcurrent protective device at the termination of the tap conductors

Exception to b: Where listed equipment, such as a surge-protective device(s) [SPD(s)], is provided with specific instructions on minimum conductor sizing, the ampacity of the tap conductors supplying that equipment shall be permitted to be determined based on the manufacturer's instructions.

- (2) The tap conductors do not extend beyond the switchboard, switchgear, panelboard, disconnecting means, or control devices they supply.
- (3) Except at the point of connection to the feeder, the tap conductors are enclosed in a raceway, which extends from the tap to the enclosure of an enclosed switchboard, switchgear, a panelboard, or control devices, or to the back of an open switchboard.
- (4) For field installations, if the tap conductors leave the enclosure or vault in which the tap is made, the ampacity of the tap conductors is not less than one-tenth of the rating of the overcurrent device protecting the feeder conductors.

Informational Note: See 408.36 for overcurrent protection requirements for panelboards.

(2) Taps Not over 7.5 m (25 ft) Long. Where the length of the tap conductors does not exceed 7.5 m (25 ft) and the tap conductors comply with all the following:

- (1) The ampacity of the tap conductors is not less than one-third of the rating of the overcurrent device protecting the feeder conductors.
- (2) The tap conductors terminate in a single circuit breaker or a single set of fuses that limit the load to the ampacity of the tap conductors. This device shall be permitted to supply any number of additional overcurrent devices on its load side.
- (3) The tap conductors are protected from physical damage by being enclosed in an approved raceway or by other approved means.

(3) Taps Supplying a Transformer [Primary Plus Secondary Not over 7.5 m (25 ft) Long]. Where the tap conductors supply a transformer and comply with all the following conditions:

- (1) The conductors supplying the primary of a transformer have an ampacity at least one-third the rating of the overcurrent device protecting the feeder conductors.
- (2) The conductors supplied by the secondary of the transformer shall have an ampacity that is not less than the value of the primary-to-secondary voltage ratio multiplied by one-third of the rating of the overcurrent device protecting the feeder conductors.
- (3) The total length of one primary plus one secondary conductor, excluding any portion of the primary conductor that is protected at its ampacity, is not over 7.5 m (25 ft).
- (4) The primary and secondary conductors are protected from physical damage by being enclosed in an approved raceway or by other approved means.
- (5) The secondary conductors terminate in a single circuit breaker or set of fuses that limit the load current to not more than the conductor ampacity that is permitted by 310.14.

(4) Taps over 7.5 m (25 ft) Long. Where the feeder is in a high bay manufacturing building over 11 m (35 ft) high at walls and the installation complies with all the following conditions:

- (1) Conditions of maintenance and supervision ensure that only qualified persons service the systems.
- (2) The tap conductors are not over 7.5 m (25 ft) long horizontally and not over 30 m (100 ft) total length.
- (3) The ampacity of the tap conductors is not less than one-third the rating of the overcurrent device protecting the feeder conductors.
- (4) The tap conductors terminate at a single circuit breaker or a single set of fuses that limit the load to the ampacity of the tap conductors. This single overcurrent device shall be permitted to supply any number of additional overcurrent devices on its load side.
- (5) The tap conductors are protected from physical damage by being enclosed in an approved raceway or by other approved means.
- (6) The tap conductors are continuous from end-to-end and contain no splices.
- (7) The tap conductors are sized 6 AWG copper or 4 AWG aluminum or larger.
- (8) The tap conductors do not penetrate walls, floors, or ceilings.
- (9) The tap is made no less than 9 m (30 ft) from the floor.

(5) Outside Taps of Unlimited Length. Where the conductors are located outside of a building or structure, except at the point of load termination, and comply with all of the following conditions:

- (1) The tap conductors are protected from physical damage in an approved manner.
- (2) The tap conductors terminate at a single circuit breaker or a single set of fuses that limits the load to the ampacity of the tap conductors. This single overcurrent device shall be permitted to supply any number of additional overcurrent devices on its load side.
- (3) The overcurrent device for the tap conductors is an integral part of a disconnecting means or shall be located immediately adjacent thereto.

- (4) The disconnecting means for the tap conductors is installed at a readily accessible location complying with one of the following:

- a. Outside of a building or structure
- b. Inside, nearest the point of entrance of the tap conductors
- c. Where installed in accordance with 230.6, nearest the point of entrance of the tap conductors

Δ (C) Transformer Secondary Conductors. A set of conductors feeding a single load, or each set of conductors feeding separate loads, shall be permitted to be connected to a transformer secondary, without overcurrent protection at the secondary, as specified in 240.21(C)(1) through (C)(6). Section 240.4(B) shall not be permitted for transformer secondary conductors.

Informational Note: See 450.3 for overcurrent protection requirements for transformers.

(1) Protection by Primary Overcurrent Device. Conductors supplied by the secondary side of a single-phase transformer having a 2-wire (single-voltage) secondary, or a three-phase, delta-delta connected transformer having a 3-wire (single-voltage) secondary, shall be permitted to be protected by overcurrent protection provided on the primary (supply) side of the transformer, provided this protection is in accordance with 450.3 and does not exceed the value determined by multiplying the secondary conductor ampacity by the secondary-to-primary transformer voltage ratio.

Single-phase (other than 2-wire) and multiphase (other than delta-delta, 3-wire) transformer secondary conductors are not considered to be protected by the primary overcurrent protective device.

Δ (2) Transformer Secondary Conductors Not over 3 m (10 ft) Long. If the length of secondary conductor does not exceed 3 m (10 ft) and complies with all of the following:

- (1) The ampacity of the secondary conductors is as follows:
 - a. Not less than the combined calculated loads on the circuits supplied by the secondary conductors
 - b. Not less than the rating of the equipment containing an overcurrent device(s) supplied by the secondary conductors or not less than the rating of the overcurrent protective device at the termination of the secondary conductors

Exception: Where listed equipment, such as a surge protective device(s) [SPD(s)], is provided with specific instructions on minimum conductor sizing, the ampacity of the tap conductors supplying that equipment shall be permitted to be determined based on the manufacturer's instructions.

- (2) The secondary conductors do not extend beyond the switchboard, switchgear, panelboard, disconnecting means, or control devices they supply.
- (3) The secondary conductors are enclosed in a raceway, which shall extend from the transformer to the enclosure of an enclosed switchboard, switchgear, a panelboard, or control devices or to the back of an open switchboard.
- (4) For field installations where the secondary conductors leave the enclosure or vault in which the supply connection is made, the secondary conductors shall have an ampacity that is not less than the value of the primary-to-secondary voltage ratio multiplied by one-tenth of the

rating of the overcurrent device protecting the primary of the transformer.

Informational Note: See 408.36 for overcurrent protection requirements for panelboards.

(3) Industrial Installation Secondary Conductors Not over 7.5 m (25 ft) Long. For the supply of switchgear or switchboards in industrial installations only, where the length of the secondary conductors does not exceed 7.5 m (25 ft) and complies with all of the following:

- (1) Conditions of maintenance and supervision ensure that only qualified persons service the systems.
- (2) The ampacity of the secondary conductors is not less than the secondary current rating of the transformer, and the sum of the ratings of the overcurrent devices does not exceed the ampacity of the secondary conductors.
- (3) All overcurrent devices are grouped.
- (4) The secondary conductors are protected from physical damage by being enclosed in an approved raceway or by other approved means.

(4) Outside Secondary Conductors. Where the conductors are located outside of a building or structure, except at the point of load termination, and comply with all of the following conditions:

- (1) The conductors are protected from physical damage in an approved manner.
- (2) The conductors terminate at a single circuit breaker or a single set of fuses that limit the load to the ampacity of the conductors. This single overcurrent device shall be permitted to supply any number of additional overcurrent devices on its load side.
- (3) The overcurrent device for the conductors is an integral part of a disconnecting means or shall be located immediately adjacent thereto.
- (4) The disconnecting means for the conductors is installed at a readily accessible location complying with one of the following:
 - a. Outside of a building or structure
 - b. Inside, nearest the point of entrance of the conductors
 - c. Where installed in accordance with 230.6, nearest the point of entrance of the conductors

(5) Secondary Conductors from a Feeder Tapped Transformer. Transformer secondary conductors installed in accordance with 240.21(B)(3) shall be permitted to have overcurrent protection as specified in that section.

(6) Secondary Conductors Not over 7.5 m (25 ft) Long. Where the length of secondary conductor does not exceed 7.5 m (25 ft) and complies with all of the following:

- (1) The secondary conductors shall have an ampacity that is not less than the value of the primary-to-secondary voltage ratio multiplied by one-third of the rating of the overcurrent device protecting the primary of the transformer.
- (2) The secondary conductors terminate in a single circuit breaker or set of fuses that limit the load current to not more than the conductor ampacity that is permitted by 310.14.
- (3) The secondary conductors are protected from physical damage by being enclosed in an approved raceway or by other approved means.

(D) Service Conductors. Service conductors shall be permitted to be protected by overcurrent devices in accordance with 230.91.

(E) Busway Taps. Busways and busway taps shall be permitted to be protected against overcurrent in accordance with 368.17.

(F) Motor Circuit Taps. Motor-feeder and branch-circuit conductors shall be permitted to be protected against overcurrent in accordance with 430.28 and 430.53, respectively.

(G) Conductors from Generator Terminals. Conductors from generator terminals that meet the size requirement in 445.13 shall be permitted to be protected against overload by the generator overload protective device(s) required by 445.12.

(H) Battery Conductors. Overcurrent protection shall be permitted to be installed as close as practicable to the storage battery terminals in an unclassified location. Installation of the overcurrent protection within a hazardous (classified) location shall also be permitted.

240.22 Grounded Conductor. No overcurrent device shall be connected in series with any conductor that is intentionally grounded, unless one of the following two conditions is met:

- (1) The overcurrent device opens all conductors of the circuit, including the grounded conductor, and is designed so that no pole can operate independently.
- (2) Where required by 430.36 or 430.37 for motor overload protection.

240.24 Location in or on Premises.

(A) Accessibility. Circuit breakers and switches containing fuses shall be readily accessible and installed so that the center of the grip of the operating handle of the switch or circuit breaker, when in its highest position, is not more than 2.0 m (6 ft 7 in.) above the floor or working platform, unless one of the following applies:

- (1) For busways, as provided in 368.17(C).
- (2) For supplementary overcurrent protection, as described in 240.10.
- (3) For overcurrent protective devices, as described in 225.40 and 230.92.
- (4) For overcurrent protective devices adjacent to utilization equipment that they supply, access shall be permitted to be by portable means.

Exception: The use of a tool shall be permitted to access overcurrent protective devices located within listed industrial control panels, within enclosures designed for hazardous (classified) locations or enclosures to protect against environmental conditions. An enclosure within the scope of this exception, and all overcurrent protective device(s) within such enclosures as judged with the enclosure open, shall comply with the accessibility provisions of 240.24(A).

(B) Occupancy. Each occupant shall have ready access to all overcurrent devices protecting the conductors supplying that occupancy, unless otherwise permitted in 240.24(B)(1) and (B)(2).

(1) Service and Feeder Overcurrent Protective Devices. Where electric service and electrical maintenance are provided by the building management and where these are under continuous building management supervision, the service overcurrent protective devices and feeder overcurrent protective devices supplying more than one occupancy shall be permitted

to be accessible only to authorized management personnel in the following:

- (1) Multiple-occupancy buildings
- (2) Guest rooms or guest suites

(2) Branch-Circuit Overcurrent Protective Devices. Where electric service and electrical maintenance are provided by the building management and where these are under continuous building management supervision, the branch-circuit overcurrent protective devices supplying any guest rooms, guest suites, or sleeping rooms in dormitory units without permanent provisions for cooking shall be permitted to be accessible only to authorized management personnel.

(C) Not Exposed to Physical Damage. Overcurrent protective devices shall be located where they will not be exposed to physical damage.

Informational Note: See 110.11 for information on deteriorating agents that could cause physical damage.

(D) Not in Vicinity of Easily Ignitable Material. Overcurrent protective devices shall not be located in the vicinity of easily ignitable material, such as in clothes closets.

(E) Not Located in Bathrooms. Overcurrent protective devices, other than supplementary overcurrent protection, shall not be located in bathrooms, showering facilities, or locker rooms with showering facilities.

(F) Not Located over Steps. Overcurrent protective devices shall not be located over steps of a stairway.

Part III. Enclosures

240.30 General.

(A) Protection from Physical Damage. Overcurrent devices shall be protected from physical damage by one of the following:

- (1) Installation in enclosures, cabinets, cutout boxes, or equipment assemblies
- (2) Mounting on open-type switchboards, panelboards, or control boards that are in rooms or enclosures free from dampness and easily ignitable material and are accessible only to qualified personnel

(B) Operating Handle. The operating handle of a circuit breaker shall be permitted to be accessible without opening a door or cover.

240.32 Damp or Wet Locations. Enclosures for overcurrent devices in damp or wet locations shall comply with 312.2.

240.33 Vertical Position. Enclosures for overcurrent devices shall be mounted in a vertical position. Circuit breaker enclosures shall be permitted to be installed horizontally where the circuit breaker is installed in accordance with 240.81. Listed busway plug-in units shall be permitted to be mounted in orientations corresponding to the busway mounting position.

Part IV. Disconnecting and Guarding

240.40 Disconnecting Means for Fuses. Cartridge fuses in circuits of any voltage, and all fuses in circuits over 150 volts to ground, shall be provided with a disconnecting means on their supply side so that each circuit containing fuses can be inde-

pendently disconnected from the source of power. A cable limiter without a disconnecting means shall be permitted on the supply side of the service disconnecting means as permitted by 230.82. A single disconnecting means shall be permitted on the supply side of more than one set of fuses as permitted by 430.112, Exception, for group operation of motors, 424.22(C) for fixed electric space-heating equipment, and 425.22(C) for fixed resistance and electrode industrial process heating equipment, or where specifically permitted elsewhere in this *Code*.

240.41 Arcing or Suddenly Moving Parts. Arcing or suddenly moving parts shall comply with 240.41(A) and (B).

(A) Location. Fuses and circuit breakers shall be located or shielded so that persons will not be burned or otherwise injured by their operation.

(B) Suddenly Moving Parts. Handles or levers of circuit breakers, and similar parts that may move suddenly in such a way that persons in the vicinity are likely to be injured by being struck by them, shall be guarded or isolated.

Part V. Plug Fuses, Fuseholders, and Adapters

240.50 General.

(A) Maximum Voltage. Plug fuses shall be permitted to be used in the following circuits:

- (1) Circuits not exceeding 125 volts between conductors
- (2) Circuits supplied by a system having a grounded neutral point where the line-to-neutral voltage does not exceed 150 volts

(B) Marking. Each fuse, fuseholder, and adapter shall be marked with its ampere rating.

(C) Hexagonal Configuration. Plug fuses of 15-ampere and lower rating shall be identified by a hexagonal configuration of the window, cap, or other prominent part to distinguish them from fuses of higher ampere ratings.

(D) No Energized Parts. Plug fuses, fuseholders, and adapters shall have no exposed energized parts after fuses or fuses and adapters have been installed.

(E) Screw Shell. The screw shell of a plug-type fuseholder shall be connected to the load side of the circuit.

240.51 Edison-Base Fuses.

(A) Classification. Plug fuses of the Edison-base type shall be classified at not over 125 volts and 30 amperes and below.

(B) Replacement Only. Plug fuses of the Edison-base type shall be used only for replacements in existing installations where there is no evidence of overfusing or tampering.

240.52 Edison-Base Fuseholders. Fuseholders of the Edison-base type shall be installed only where they are made to accept Type S fuses by the use of adapters.

240.53 Type S Fuses. Type S fuses shall be of the plug type and shall comply with 240.53(A) and (B).

(A) Classification. Type S fuses shall be classified at not over 125 volts and 0 to 15 amperes, 16 to 20 amperes, and 21 to 30 amperes.

(B) Noninterchangeable. Type S fuses of an ampere classification as specified in 240.53(A) shall not be interchangeable with

a lower ampere classification. They shall be designed so that they cannot be used in any fuseholder other than a Type S fuseholder or a fuseholder with a Type S adapter inserted.

240.54 Type S Fuses, Adapters, and Fuseholders.

(A) To Fit Edison-Base Fuseholders. Type S adapters shall fit Edison-base fuseholders.

(B) To Fit Type S Fuses Only. Type S fuseholders and adapters shall be designed so that either the fuseholder itself or the fuseholder with a Type S adapter inserted cannot be used for any fuse other than a Type S fuse.

(C) Nonremovable. Type S adapters shall be designed so that once inserted in a fuseholder, they cannot be removed.

(D) Nontamperable. Type S fuses, fuseholders, and adapters shall be designed so that tampering or shunting (bridging) would be difficult.

(E) Interchangeability. Dimensions of Type S fuses, fuseholders, and adapters shall be standardized to permit interchangeability regardless of the manufacturer.

Part VI. Cartridge Fuses and Fuseholders

240.60 General.

(A) Maximum Voltage — 300-Volt Type. Cartridge fuses and fuseholders of the 300-volt type shall be permitted to be used in the following circuits:

- (1) Circuits not exceeding 300 volts between conductors
- (2) Single-phase line-to-neutral circuits supplied from a 3-phase, 4-wire, solidly grounded neutral source where the line-to-neutral voltage does not exceed 300 volts

(B) Noninterchangeable — 0–6000-Ampere Cartridge Fuseholders. Fuseholders shall be designed so that it will be difficult to put a fuse of any given class into a fuseholder that is designed for a current lower, or voltage higher, than that of the class to which the fuse belongs. Fuseholders for current-limiting fuses shall not permit insertion of fuses that are not current-limiting.

(C) Marking. Fuses shall be plainly marked, either by printing on the fuse barrel or by a label attached to the barrel showing the following:

- (1) Ampere rating
- (2) Voltage rating
- (3) Interrupting rating where other than 10,000 amperes
- (4) Current limiting where applicable
- (5) The name or trademark of the manufacturer

The interrupting rating shall not be required to be marked on fuses used for supplementary protection.

(D) Renewable Fuses. Class H cartridge fuses of the renewable type shall be permitted to be used only for replacement in existing installations where there is no evidence of overfusing or tampering.

(E) Fuse Reducers. Fuse reducers shall be listed.

240.61 Classification. Cartridge fuses and fuseholders shall be classified according to voltage and amperage ranges. Fuses rated 1000 volts, nominal, or less shall be permitted to be used for voltages at or below their ratings.

Δ 240.67 Arc Energy Reduction. Where fuses rated 1200 amperes or higher are installed, 240.67(A), (B), and (C) shall apply.

(A) Documentation. Documentation shall be available to those authorized to design, install, operate, or inspect the installation as to the location of the fuses.

Documentation shall also be provided to demonstrate that the method chosen to reduce clearing time is set to operate at a value below the available arcing current.

Δ (B) Method to Reduce Clearing Time. A fuse shall have a clearing time of 0.07 seconds or less at the available arcing current, or one of the following means shall be provided and shall be set to operate at less than the available arcing current:

- (1) Differential relaying
- (2) Energy-reducing maintenance switching with local status indicator
- (3) Energy-reducing active arc-flash mitigation system
- (4) Current-limiting, electronically actuated fuses
- (5) An approved equivalent means

Informational Note No. 1: An energy-reducing maintenance switch allows a worker to set a disconnect switch to reduce the clearing time while the worker is working within an arc-flash boundary as defined in *NFPA 70E-2021, Standard for Electrical Safety in the Workplace*, and then to set the disconnect switch back to a normal setting after the potentially hazardous work is complete.

Informational Note No. 2: An energy-reducing active arc-flash mitigation system helps in reducing arcing duration in the electrical distribution system. No change in the disconnect switch or the settings of other devices is required during maintenance when a worker is working within an arc-flash boundary as defined in *NFPA 70E-2021, Standard for Electrical Safety in the Workplace*.

Informational Note No. 3: IEEE 1584-2018, *IEEE Guide for Performing Arc Flash Hazard Calculations*, provides guidance in determining arcing current.

(C) Performance Testing. The arc energy reduction protection system shall be performance tested by primary current injection testing or another approved method when first installed on site. This testing shall be conducted by a qualified person(s) in accordance with the manufacturer's instructions.

A written record of this testing shall be made and shall be available to the authority having jurisdiction.

Informational Note: Some energy reduction protection systems cannot be tested using a test process of primary current injection due to either the protection method being damaged such as with the use of fuse technology or because current is not the primary method of arc detection.

Part VII. Circuit Breakers

240.80 Method of Operation. Circuit breakers shall be trip free and capable of being closed and opened by manual operation. Their normal method of operation by other than manual means, such as electrical or pneumatic, shall be permitted if means for manual operation are also provided.

240.81 Indicating. Circuit breakers shall clearly indicate whether they are in the open "off" or closed "on" position.

Where circuit breaker handles are operated vertically rather than rotationally or horizontally, the "up" position of the handle shall be the "on" position.

240.82 Nontamperable. A circuit breaker shall be of such design that any alteration of its trip point (calibration) or the time required for its operation requires dismantling of the device or breaking of a seal for other than intended adjustments.

240.83 Marking.

(A) Durable and Visible. Circuit breakers shall be marked with their ampere rating in a manner that will be durable and visible after installation. Such marking shall be permitted to be made visible by removal of a trim or cover.

(B) Location. Circuit breakers rated at 100 amperes or less and 1000 volts or less shall have the ampere rating molded, stamped, etched, or similarly marked into their handles or escutcheon areas.

(C) Interrupting Rating. Every circuit breaker having an interrupting rating other than 5000 amperes shall have its interrupting rating shown on the circuit breaker. The interrupting rating shall not be required to be marked on circuit breakers used for supplementary protection.

(D) Used as Switches. Circuit breakers used as switches in 120-volt and 277-volt fluorescent lighting circuits shall be listed and shall be marked SWD or HID. Circuit breakers used as switches in high-intensity discharge lighting circuits shall be listed and shall be marked as HID.

(E) Voltage Marking. Circuit breakers shall be marked with a voltage rating not less than the nominal system voltage that is indicative of their capability to interrupt fault currents between phases or phase to ground.

240.85 Applications. A circuit breaker with a straight voltage rating, such as 240V or 480V, shall be permitted to be applied in a circuit in which the nominal voltage between any two conductors does not exceed the circuit breaker's voltage rating. A two-pole circuit breaker shall not be used for protecting a 3-phase, corner-grounded delta circuit unless the circuit breaker is marked 1 ϕ -3 ϕ to indicate such suitability.

A circuit breaker with a slash rating, such as 120/240V or 480Y/277V, shall be permitted to be applied in a solidly grounded circuit where the nominal voltage of any conductor to ground does not exceed the lower of the two values of the circuit breaker's voltage rating and the nominal voltage between any two conductors does not exceed the higher value of the circuit breaker's voltage rating.

Informational Note: Proper application of molded case circuit breakers on 3-phase systems, other than solidly grounded wye, particularly on corner grounded delta systems, considers the circuit breakers' individual pole-interrupting capability.

240.86 Series Ratings. Where a circuit breaker is used on a circuit having an available fault current higher than the marked interrupting rating by being connected on the load side of an approved overcurrent protective device having a higher rating, the circuit breaker shall meet the requirements specified in 240.86(A) or (B), and (C).

(A) Selected Under Engineering Supervision in Existing Installations. The series rated combination devices shall be selected by a licensed professional engineer engaged primarily in the

design or maintenance of electrical installations. The selection shall be documented and stamped by the professional engineer. This documentation shall be available to those authorized to design, install, inspect, maintain, and operate the system. This series combination rating, including identification of the upstream device, shall be field marked on the end use equipment.

For calculated applications, the engineer shall ensure that the downstream circuit breaker(s) that are part of the series combination remain passive during the interruption period of the line side fully rated, current-limiting device.

Informational Note: See 110.22 for marking of series combination systems.

(B) Tested Combinations. The combination of line-side overcurrent device and load-side circuit breaker(s) is tested and marked on the end use equipment, such as switchboards and panelboards.

Informational Note: See 110.22 for marking of series combination systems.

Δ (C) Motor Contribution. Series ratings shall not be used in the following situations:

- (1) Where motor circuits are connected between the higher-rated overcurrent device of a series-rated combination and on the lower-rated circuit breaker
- (2) Where the sum of these motor full-load currents exceeds 1 percent of the interrupting rating of the lower-rated circuit breaker

240.87 Arc Energy Reduction. Where the highest continuous current trip setting for which the actual overcurrent device installed in a circuit breaker is rated or can be adjusted is 1200 amperes or higher, 240.87(A), (B), and (C) shall apply.

(A) Documentation. Documentation shall be available to those authorized to design, install, operate, or inspect the installation as to the location of the circuit breaker(s). Documentation shall also be provided to demonstrate that the method chosen to reduce clearing time is set to operate at a value below the available arcing current.

(B) Method to Reduce Clearing Time. One of the following means shall be provided and shall be set to operate at less than the available arcing current:

- (1) Zone-selective interlocking
- (2) Differential relaying
- (3) Energy-reducing maintenance switching with local status indicator
- (4) Energy-reducing active arc flash mitigation system
- (5) An instantaneous trip setting. Temporary adjustment of the instantaneous trip setting to achieve arc energy reduction shall not be permitted.
- (6) An instantaneous override
- (7) An approved equivalent means

Informational Note No. 1: An energy-reducing maintenance switch allows a worker to set a circuit breaker trip unit to “no intentional delay” to reduce the clearing time while the worker is working within an arc-flash boundary as defined in *NFPA 70E-2021, Standard for Electrical Safety in the Workplace*, and then to set the trip unit back to a normal setting after the potentially hazardous work is complete.

Informational Note No. 2: An energy-reducing active arc-flash mitigation system helps in reducing arcing duration in the elec-

trical distribution system. No change in the circuit breaker or the settings of other devices is required during maintenance when a worker is working within an arc-flash boundary as defined in *NFPA 70E-2021, Standard for Electrical Safety in the Workplace*.

Informational Note No. 3: An instantaneous trip is a function that causes a circuit breaker to trip with no intentional delay when currents exceed the instantaneous trip setting or current level. If arcing currents are above the instantaneous trip level, the circuit breaker will trip in the minimum possible time.

Informational Note No. 4: See IEEE 1584-2018, *IEEE Guide for Performing Arc Flash Hazard Calculations*, for guidance in determining arcing current.

(C) Performance Testing. The arc energy reduction protection system shall be performance tested by primary current injection testing or another approved method when first installed on site. This testing shall be conducted by a qualified person(s) in accordance with the manufacturer’s instructions.

A written record of this testing shall be made and shall be available to the authority having jurisdiction.

Informational Note: Some energy reduction protection systems cannot be tested using a test process of primary current injection due to either the protection method being damaged such as with the use of fuse technology or because current is not the primary method of arc detection.

• N 240.89 Replacement Trip Units. Replacement trip units shall be listed for use with the circuit breaker type in which it is installed.

Informational Note: The replacement trip unit can be a listed unit identical to the original or a different trip unit listed for use with the specific circuit breaker.

Part VIII. Supervised Industrial Installations

240.90 General. Overcurrent protection in areas of supervised industrial installations shall comply with all of the other applicable provisions of this article, except as provided in Part VIII. Part VIII shall be permitted to apply only to those portions of the electrical system in the supervised industrial installation used exclusively for manufacturing or process control activities.

240.91 Protection of Conductors. Conductors shall be protected in accordance with 240.91(A) or 240.91(B).

(A) General. Conductors shall be protected in accordance with 240.4.

(B) Devices Rated Over 800 Amperes. Where the overcurrent device is rated over 800 amperes, the ampacity of the conductors it protects shall be equal to or greater than 95 percent of the rating of the overcurrent device in accordance with the following:

- (1) The conductors are protected within recognized time vs. current limits for short-circuit currents

Informational Note: Table 240.92(B) provides time vs. short-circuit current formulas to determine limits for copper and aluminum conductors.

- (2) All equipment in which the conductors terminate is listed and marked for the application.

240.92 Location in Circuit. An overcurrent device shall be connected in each ungrounded circuit conductor as required in 240.92(A) through (E).

(A) Feeder and Branch-Circuit Conductors. Feeder and branch-circuit conductors shall be protected at the point the conductors receive their supply as permitted in 240.21 or as otherwise permitted in 240.92(B), (C), (D), or (E).

(B) Feeder Taps. For feeder taps specified in 240.21(B)(2), (B)(3), and (B)(4), the tap conductors shall be permitted to be sized in accordance with Table 240.92(B).

(C) Transformer Secondary Conductors of Separately Derived Systems. Conductors shall be permitted to be connected to a transformer secondary of a separately derived system, without overcurrent protection at the connection, where the conditions of 240.92(C)(1), (C)(2), and (C)(3) are met.

(1) Short-Circuit and Ground-Fault Protection. The conductors shall be protected from short-circuit and ground-fault conditions by complying with one of the following conditions:

- (1) The length of the secondary conductors does not exceed 30 m (100 ft), and the transformer primary overcurrent device has a rating or setting that does not exceed 150 percent of the value determined by multiplying the secondary conductor ampacity by the secondary-to-primary transformer voltage ratio.

Table 240.92(B) Tap Conductor Short-Circuit Current Ratings

Tap conductors are considered to be protected under short-circuit conditions when their short-circuit temperature limit is not exceeded. Conductor heating under short-circuit conditions is determined by (1) or (2):

(1) *Short-Circuit Formula for Copper Conductors*

$$(\bar{I}^2 / A^2) t = 0.0297 \log_{10} [(T_2 + 234) / (T_1 + 234)]$$

(2) *Short-Circuit Formula for Aluminum Conductors*

$$(\bar{I}^2 / A^2) t = 0.0125 \log_{10} [(T_2 + 228) / (T_1 + 228)]$$

where:

$\bar{I}$ = short-circuit current in amperes

A = conductor area in circular mils

t = time of short circuit in seconds (for times less than or equal to 10 seconds)

T_1 = initial conductor temperature in degrees Celsius

T_2 = final conductor temperature in degrees Celsius

Copper conductor with paper, rubber, varnished cloth insulation,
 $T_2 = 200$

Copper conductor with thermoplastic insulation, $T_2 = 150$

Copper conductor with cross-linked polyethylene insulation,
 $T_2 = 250$

Copper conductor with ethylene propylene rubber insulation,
 $T_2 = 250$

Aluminum conductor with paper, rubber, varnished cloth insulation, $T_2 = 200$

Aluminum conductor with thermoplastic insulation, $T_2 = 150$

Aluminum conductor with cross-linked polyethylene insulation,
 $T_2 = 250$

Aluminum conductor with ethylene propylene rubber insulation,
 $T_2 = 250$

- (2) The conductors are protected by a differential relay with a trip setting equal to or less than the conductor ampacity.

Informational Note: A differential relay is connected to be sensitive only to short-circuit or fault currents within the protected zone and is normally set much lower than the conductor ampacity. The differential relay is connected to trip protective devices that de-energize the protected conductors if a short-circuit condition occurs.

- (3) The conductors shall be considered to be protected if calculations, made under engineering supervision, determine that the system overcurrent devices will protect the conductors within recognized time vs. current limits for all short-circuit and ground-fault conditions.

(2) Overload Protection. The conductors shall be protected against overload conditions by complying with one of the following:

- (1) The conductors terminate in a single overcurrent device that will limit the load to the conductor ampacity.
- (2) The sum of the overcurrent devices at the conductor termination limits the load to the conductor ampacity. The overcurrent devices shall consist of not more than six circuit breakers or sets of fuses mounted in a single enclosure, in a group of separate enclosures, or in or on a switchboard or switchgear. There shall be no more than six overcurrent devices grouped in any one location.
- (3) Overcurrent relaying is connected [with a current transformer(s), if needed] to sense all of the secondary conductor current and limit the load to the conductor ampacity by opening upstream or downstream devices.
- (4) Conductors shall be considered to be protected if calculations, made under engineering supervision, determine that the system overcurrent devices will protect the conductors from overload conditions.

(3) Physical Protection. The secondary conductors are protected from physical damage by being enclosed in an approved raceway or by other approved means.

(D) Outside Feeder Taps. Outside conductors shall be permitted to be tapped to a feeder or to be connected at a transformer secondary, without overcurrent protection at the tap or connection, where all the following conditions are met:

- (1) The conductors are protected from physical damage in an approved manner.
- (2) The sum of the overcurrent devices at the conductor termination limits the load to the conductor ampacity. The overcurrent devices shall consist of not more than six circuit breakers or sets of fuses mounted in a single enclosure, in a group of separate enclosures, or in or on a switchboard or switchgear. There shall be no more than six overcurrent devices grouped in any one location.
- (3) The tap conductors are installed outdoors of a building or structure except at the point of load termination.
- (4) The overcurrent device for the conductors is an integral part of a disconnecting means or is located immediately adjacent thereto.
- (5) The disconnecting means for the conductors are installed at a readily accessible location complying with one of the following:
 - a. Outside of a building or structure
 - b. Inside, nearest the point of entrance of the conductors

- c. Where installed in accordance with 230.6, nearest the point of entrance of the conductors

(E) Protection by Primary Overcurrent Device. Conductors supplied by the secondary side of a transformer shall be permitted to be protected by overcurrent protection provided on the primary (supply) side of the transformer, provided the primary device time-current protection characteristic, multiplied by the maximum effective primary-to-secondary transformer voltage ratio, effectively protects the secondary conductors.

ARTICLE 242 Overvoltage Protection

Part I. General

Δ 242.1 Scope. This article provides the general requirements, installation requirements, and connection requirements for overvoltage protection and overvoltage protective devices. Part II covers surge-protective devices (SPDs) permanently installed on premises wiring systems of not more than 1000 volts, nominal, while Part III covers surge arresters permanently installed on premises wiring systems over 1000 volts, nominal.

N 242.2 Reconditioned Equipment. SPDs and surge arresters shall not be reconditioned.

242.3 Other Articles. Equipment shall be protected against overvoltage in accordance with the article in this *Code* that covers the type of equipment or location specified in Table 242.3.

Δ Part II. Surge-Protective Devices (SPDs), 1000 Volts or Less

242.6 Listing. An SPD shall be a listed device.

Δ Table 242.3 Other Articles

Equipment	Article
Class I locations	501
Class II locations	502
Community antenna television and radio distribution systems	820
Critical operations power systems	708
Elevators, dumbwaiters, escalators, moving walks, platform lifts, and stairway chairlifts	620
Emergency systems	700
Equipment over 1000 volts, nominal	495
Fire pumps	695
Industrial machinery	670
Information technology equipment	645
Modular data centers	646
Outdoor overhead conductors over 1000 volts	395
Radio and television equipment	810
Receptacles, cord connectors, and attachment plugs (caps)	406
Wind electric systems	694

242.8 Short-Circuit Current Rating. The SPD shall be marked with a short-circuit current rating and shall not be installed at a point on the system where the available fault current is in excess of that rating. This marking requirement shall not apply to receptacles.

N 242.9 Indicating. An SPD shall provide indication that it is functioning properly.

242.12 Uses Not Permitted. An SPD device shall not be installed in the following:

- (1) Circuits over 1000 volts
- (2) On ungrounded systems, impedance grounded systems, or corner grounded delta systems unless listed specifically for use on these systems
- (3) Where the rating of the SPD is less than the maximum continuous phase-to-ground voltage at the power frequency available at the point of application

242.13 Type 1 SPDs. Type 1 SPDs shall be installed in accordance with 242.13(A) and (B).

(A) Installation. Type 1 SPDs shall be permitted to be connected in accordance with one of the following:

- (1) To the supply side of the service disconnect as permitted in 230.82(4)
- (2) As specified in 242.14

(B) At the Service. When installed at services, Type 1 SPDs shall be connected to one of the following:

- (1) Grounded service conductor
- (2) Grounding electrode conductor
- (3) Grounding electrode for the service
- (4) Equipment grounding terminal in the service equipment

242.14 Type 2 SPDs. Type 2 SPDs shall be installed in accordance with 242.14(A) through (C).

(A) Service-Supplied Building or Structure. Type 2 SPDs shall be connected anywhere on the load side of a service disconnect overcurrent device required in 230.91 unless installed in accordance with 230.82(8).

(B) Feeder-Supplied Building or Structure. Type 2 SPDs shall be connected at the building or structure anywhere on the load side of the first overcurrent device at the building or structure.

(C) Separately Derived System. The SPD shall be connected on the load side of the first overcurrent device in a separately derived system.

242.16 Type 3 SPDs. Type 3 SPDs shall be permitted to be installed on the load side of branch-circuit overcurrent protection up to the equipment served. If included in the manufacturer's instructions, the Type 3 SPD connection shall be a minimum 10 m (30 ft) of conductor distance from the service or separately derived system disconnect.

242.18 Type 4 and Other Component Type SPDs. Type 4 component assemblies and other component type SPDs shall only be installed by the equipment manufacturer.

242.20 Number Required. Where used at a point on a circuit, the SPD shall be connected to each ungrounded conductor.

242.22 Location. SPDs shall be permitted to be located indoors or outdoors and shall be made inaccessible to unqualified persons unless listed for installation in accessible locations.

242.24 Routing of Conductors. The conductors used to connect the SPD to the line or bus and to ground shall not be any longer than necessary and shall avoid unnecessary bends.

242.28 Conductor Size. SPD line conductors and conductors to ground shall not be smaller than 14 AWG copper or 12 AWG aluminum.

242.30 Connection Between Conductors. An SPD shall be permitted to be connected between any two conductors — ungrounded conductor(s), grounded conductor, equipment grounding conductor, or grounding electrode conductor. The grounded conductor and the equipment grounding conductor shall be interconnected only by the normal operation of the SPD during a surge.

242.32 Grounding Electrode Conductor Connections and Enclosures. Except as indicated in this article, SPD grounding connections shall be made as specified in Article 250, Part III. Grounding electrode conductors installed in metal enclosures shall comply with 250.64(E).

Part III. Surge Arresters, Over 1000 Volts

242.40 Uses Not Permitted. A surge arrester shall not be installed where the rating of the surge arrester is less than the maximum continuous phase-to-ground voltage at the power frequency available at the point of application.

242.42 Surge Arrester Rating. The duty cycle rating of a surge arrester shall be not less than 125 percent of the maximum continuous operating voltage available at the point of application.

For solidly grounded systems, the maximum continuous operating voltage shall be the phase-to-ground voltage of the system.

For impedance or ungrounded systems, the maximum continuous operating voltage shall be the phase-to-phase voltage of the system.

Informational Note No. 1: See IEEE C62.11-2020, *Standard for Metal-Oxide Surge Arresters for Alternating-Current Power Circuits (>1 kV)*, and IEEE C62.22-2009, *Guide for the Application of Metal-Oxide Surge Arresters for Alternating-Current Systems*, for further information on surge arresters.

Informational Note No. 2: The selection of a properly rated metal oxide arrester is based on considerations of maximum continuous operating voltage and the magnitude and duration of overvoltages at the arrester location as affected by phase-to-ground faults, system grounding techniques, switching surges, and other causes. See the manufacturer's application rules for selection of the specific arrester to be used at a particular location.

242.44 Number Required. Where used at a point on a circuit, a surge arrester shall be connected to each ungrounded conductor. A single installation of such surge arresters shall be permitted to protect a number of interconnected circuits if no circuit is exposed to surges while disconnected from the surge arresters.

242.46 Location. Surge arresters shall be permitted to be located indoors or outdoors. Surge arresters shall be made inaccessible to unqualified persons unless listed for installation in accessible locations.

242.48 Routing of Surge Arrester Equipment Grounding Conductors. The conductor used to connect the surge arrester to line, bus, or equipment and to an equipment grounding conductor or grounding electrode connection point as provided in 242.50 shall not be any longer than necessary and shall avoid unnecessary bends.

242.50 Connection. The arrester shall be connected to one of the following:

- (1) Grounded service conductor
- (2) Grounding electrode conductor
- (3) Grounding electrode for the service
- (4) Equipment grounding terminal in the service equipment

242.52 Surge-Arrester Conductors. The conductor between the surge arrester and the line, and the surge arrester and the grounding connection, shall not be smaller than 6 AWG copper or aluminum.

242.54 Interconnections. The surge arrester protecting a transformer that supplies a secondary distribution system shall be interconnected as specified in 242.54(A), (B), or (C).

(A) Metal Interconnections. A metal interconnection shall be made to the secondary grounded circuit conductor or the secondary circuit grounding electrode conductor, if, in addition to the direct grounding connection at the surge arrester, the connection complies with 242.54(A)(1) or (A)(2).

(1) Additional Grounding Connection. The grounded conductor of the secondary has a grounding connection elsewhere to a continuous metal underground water piping system. In urban water-pipe areas where there are at least four water-pipe connections on the neutral conductor and not fewer than four such connections in each mile of neutral conductor, the metal interconnection shall be permitted to be made to the secondary neutral conductor with omission of the direct grounding connection at the surge arrester.

(2) Multigrounded Neutral System Connection. The grounded conductor of the secondary system is part of a multigrounded neutral system or static wire of which the primary neutral conductor or static wire has at least four grounding connections in each 1.6 km (1 mile) of line in addition to a grounding connection at each service.

(B) Through Spark Gap or Device. Where the surge arrester grounding electrode conductor is not connected as in 242.54(A), or where the secondary is not grounded as in 242.54(A) but is otherwise grounded as in 250.52, an interconnection shall be made through a spark gap or listed device as required by 242.54(B)(1) or (B)(2).

(1) Ungrounded or Unigrounded Primary System. For ungrounded or unigrounded primary systems, the spark gap or a listed device shall have a 60-Hz breakdown voltage of at least twice the primary circuit voltage but not necessarily more than 10 kV, and there shall be at least one other ground on the grounded conductor of the secondary that is not less than 6.0 m (20 ft) distant from the surge-arrester grounding electrode.

(2) Multigrounded Neutral Primary System. For multigrounded neutral primary systems, the spark gap or listed device shall have a 60-Hz breakdown of not more than 3 kV, and there shall be at least one other ground on the grounded conductor of the secondary that is not less than 6.0 m (20 ft) distant from the surge-arrester grounding electrode.

(C) **By Special Permission.** An interconnection of the surge-arrester ground and the secondary neutral conductor, other than as provided in 242.54(A) or (B), shall be permitted to be made only by special permission.

242.56 Grounding Electrode Conductor Connections and Enclosures. Except as indicated in this article, surge-arrester grounding electrode conductor connections shall be made as specified in Article 250, Parts III and X. Grounding electrode conductors installed in metal enclosures shall comply with 250.64(E).

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ARTICLE 245

Overcurrent Protection for Systems Rated Over 1000 Volts ac, 1500 Volts dc

N 245.1 Scope. This article covers overcurrent protection requirements for systems over 1000 volts ac, 1500 volts dc, nominal.

N 245.2 Reconditioned Equipment.

N (A) Reconditioned Equipment Permitted. The following reconditioned equipment shall be permitted:

- (1) Medium- and high-voltage circuit breakers
- (2) Electromechanical protective relays and current transformers

N (B) Reconditioned Equipment Not Permitted. Medium-voltage fuseholders and medium-voltage nonrenewable fuses shall not be permitted.

N 245.21 Circuit-Interrupting Devices.

N (A) Circuit Breakers.

N (1) Location.

(a) Circuit breakers installed indoors shall be mounted either in metal-enclosed units or fire-resistant cell-mounted units, or they shall be permitted to be open-mounted in locations accessible to qualified persons only.

(b) Circuit breakers used to control oil-filled transformers in a vault shall either be located outside the transformer vault or be capable of operation from outside the vault.

(c) Oil circuit breakers shall be arranged or located so that adjacent readily combustible structures or materials are safeguarded in an approved manner.

N (2) Operating Characteristics. Circuit breakers shall have the following equipment or operating characteristics:

- (1) An accessible mechanical or other identified means for manual tripping, independent of control power
- (2) Be release free (trip free)
- (3) If capable of being opened or closed manually while energized, main contacts that operate independently of the speed of the manual operation
- (4) A mechanical position indicator at the circuit breaker to show the open or closed position of the main contacts
- (5) A means of indicating the open and closed position of the breaker at the point(s) from which they may be operated

N (3) Nameplate. A circuit breaker shall have a permanent and legible nameplate showing the manufacturer's name or trademark, manufacturer's type or identification number, continuous current rating, interrupting rating in megavolt-amperes (MVA) or amperes, and maximum voltage rating. Modification of a circuit breaker affecting its rating(s) shall be accompanied by an appropriate change of nameplate information.

N (4) Rating. Circuit breakers shall have the following ratings:

- (1) The continuous current rating of a circuit breaker shall not be less than the maximum continuous current through the circuit breaker.
- (2) The interrupting rating of a circuit breaker shall not be less than the available fault current the circuit breaker will be required to interrupt, including contributions from all connected sources of energy.
- (3) The closing rating of a circuit breaker shall not be less than the maximum asymmetrical fault current into which the circuit breaker can be closed.
- (4) The momentary rating of a circuit breaker shall not be less than the maximum asymmetrical fault current at the point of installation.
- (5) The rated maximum voltage of a circuit breaker shall not be less than the maximum circuit voltage.

N (5) Retrofit Trip Units. Retrofit trip units shall be listed for use with the specific circuit breaker with which it is installed.

N (B) Power Fuses and Fuseholders.

N (1) Use. Where fuses are used to protect conductors and equipment, a fuse shall be placed in each ungrounded conductor. Two power fuses shall be permitted to be used in parallel to protect the same load if both fuses have identical ratings and both fuses are installed in an identified common mounting with electrical connections that divide the current equally. Power fuses of the vented type shall not be used indoors, underground, or in metal enclosures unless identified for the use.

N (2) Interrupting Rating. The interrupting rating of power fuses shall not be less than the available fault current the fuse is required to interrupt, including contributions from all connected sources of energy.

N (3) Voltage Rating. The maximum voltage rating of power fuses shall not be less than the maximum circuit voltage. Fuses having a minimum recommended operating voltage shall not be applied below this voltage.

N (4) Identification of Fuse Mountings and Fuse Units. Fuse mountings and fuse units shall have permanent and legible nameplates showing the manufacturer's type or designation, continuous current rating, interrupting current rating, and maximum voltage rating.

N (5) Fuses. Fuses that expel flame in opening the circuit shall be designed or arranged so that they function properly without hazard to persons or property.

N (6) Fuseholders. Fuseholders shall be designed or installed so that they are de-energized while a fuse is being replaced. A field-applied permanent and legible sign, in accordance with 110.21(B), shall be installed immediately adjacent to the fuseholders and shall be worded as follows:

DANGER — DISCONNECT CIRCUIT BEFORE REPLACING FUSES.

Exception: Fuses and fuseholders designed to permit fuse replacement by qualified persons using identified equipment without de-energizing the fuseholder shall be permitted.

- (7) High-Voltage Fuses.** Switchgear and substations that use high-voltage fuses shall be provided with a gang-operated disconnecting switch. Isolation of the fuses from the circuit shall be provided by either connecting a switch between the source and the fuses or providing roll-out switch and fuse-type construction. The switch shall be of the load-interrupter type, unless mechanically or electrically interlocked with a load-interrupting device arranged to reduce the load to the interrupting capability of the switch.

Exception: More than one switch shall be permitted as the disconnecting means for one set of fuses where the switches are installed to provide connection to more than one set of supply conductors. The switches shall be mechanically or electrically interlocked to permit access to the fuses only when all switches are open. A conspicuous sign shall be placed at the fuses identifying the presence of more than one source.

(C) Distribution Cutouts and Fuse Links — Expulsion Type.

- (1) Installation.** Cutouts shall be located so that they may be readily and safely operated and re-fused, and so that the exhaust of the fuses does not endanger persons. Distribution cutouts shall not be used indoors, underground, or in metal enclosures.

- (2) Operation.** Where fused cutouts are not suitable to interrupt the circuit manually while carrying full load, an approved means shall be installed to interrupt the entire load. Unless the fused cutouts are interlocked with the switch to prevent opening of the cutouts under load, a conspicuous sign shall be placed at such cutouts identifying that they shall not be operated under load.

- (3) Interrupting Rating.** The interrupting rating of distribution cutouts shall not be less than the available fault current the cutout is required to interrupt, including contributions from all connected sources of energy.

- (4) Voltage Rating.** The maximum voltage rating of cutouts shall not be less than the maximum circuit voltage.

- (5) Identification.** Distribution cutouts shall have on their body, door, or fuse tube a permanent and legible nameplate or identification showing the manufacturer's type or designation, continuous current rating, maximum voltage rating, and interrupting rating.

- (6) Fuse Links.** Fuse links shall have a permanent and legible identification showing continuous current rating and type.

- (7) Structure Mounted Outdoors.** The height of cutouts mounted outdoors on structures shall provide safe clearance between lowest energized parts (open or closed position) and standing surfaces, in accordance with 110.34(E).

(D) Oil-Filled Cutouts.

- (1) Continuous Current Rating.** The continuous current rating of oil-filled cutouts shall not be less than the maximum continuous current through the cutout.

- (2) Interrupting Rating.** The interrupting rating of oil-filled cutouts shall not be less than the available fault current the oil-filled cutout is required to interrupt, including contributions from all connected sources of energy.

- (3) Voltage Rating.** The maximum voltage rating of oil-filled cutouts shall not be less than the maximum circuit voltage.

- (4) Fault Closing Rating.** Oil-filled cutouts shall have a fault closing rating not less than the maximum asymmetrical fault current that can occur at the cutout location, unless suitable interlocks or operating procedures preclude the possibility of closing into a fault.

- (5) Identification.** Oil-filled cutouts shall have a permanent and legible nameplate showing the rated continuous current, rated maximum voltage, and rated interrupting current.

- (6) Fuse Links.** Fuse links shall have a permanent and legible identification showing the rated continuous current.

- (7) Location.** Cutouts shall be located so that they are readily and safely accessible for re-fusing, with the top of the cutout not over 1.5 m (5 ft) above the floor or platform.

- (8) Enclosure.** Suitable barriers or enclosures shall be provided to prevent contact with nonshielded cables or energized parts of oil-filled cutouts.

- (E) Load Interrupters.** Load-interrupter switches shall be permitted if suitable fuses or circuit breakers are used in conjunction with these devices to interrupt available fault currents. Where these devices are used in combination, they shall be coordinated electrically so that they will safely withstand the effects of closing, carrying, or interrupting all possible currents up to the assigned maximum short-circuit rating.

Where more than one switch is installed with interconnected load terminals to provide for alternate connection to different supply conductors, each switch shall be provided with a warning sign identifying the presence of more than one source. Each warning sign or label shall comply with 110.21.

- (1) Continuous Current Rating.** The continuous current rating of interrupter switches shall equal or exceed the maximum continuous current at the point of installation.

- (2) Voltage Rating.** The maximum voltage rating of interrupter switches shall equal or exceed the maximum circuit voltage.

- (3) Identification.** Interrupter switches shall have a permanent and legible nameplate, including the following information: manufacturer's type or designation, continuous current rating, interrupting current rating, fault closing rating, maximum voltage rating.

- (4) Switching of Conductors.** The switching mechanism shall be arranged to be operated from a location where the operator is not exposed to energized parts and shall be arranged to open all ungrounded conductors of the circuit simultaneously with one operation. Switches shall be arranged to be locked in the open position. Metal-enclosed switches shall be operable from outside the enclosure.

- (5) Stored Energy for Opening.** The stored-energy operator shall be permitted to be left in the uncharged position after the switch has been closed if a single movement of the operating handle charges the operator and opens the switch.

- (6) Supply Terminals.** The supply terminals of fused interrupter switches shall be installed at the top of the switch enclosure, or, if the terminals are located elsewhere, the equipment shall have barriers installed to prevent persons from acciden-

tally contacting energized parts or dropping tools or fuses into energized parts.

N 245.26 Feeders and Branch Circuits.

N (A) Location and Type of Protection. Feeder and branch-circuit conductors shall have overcurrent protection in each ungrounded conductor located at the point where the conductor receives its supply or at an alternative location in the circuit when designed under engineering supervision that includes but is not limited to considering the appropriate fault studies and time-current coordination analysis of the protective devices and the conductor damage curves. The overcurrent protection shall be permitted to be provided by either 250.184(B) or (A) (2).

N (1) Overcurrent Relays and Current Transformers. Circuit breakers used for overcurrent protection of 3-phase circuits shall have a minimum of three overcurrent relay elements operated from three current transformers. The separate overcurrent relay elements (or protective functions) shall be permitted to be part of a single electronic protective relay unit.

On 3-phase, 3-wire circuits, an overcurrent relay element in the residual circuit of the current transformers shall be permitted to replace one of the phase relay elements.

An overcurrent relay element, operated from a current transformer that links all phases of a 3-phase, 3-wire circuit, shall be permitted to replace the residual relay element and one of the phase-conductor current transformers. Where the neutral conductor is not regrounded on the load side of the circuit as permitted in 250.184(B), the current transformer shall be permitted to link all 3-phase conductors and the grounded circuit conductor (neutral).

N (2) Fuses. A fuse shall be connected in series with each ungrounded conductor.

N (B) Protective Devices. The protective device(s) shall be capable of detecting and interrupting all values of current that can occur at their location in excess of their trip-setting or melting point.

N (C) Conductor Protection. The operating time of the protective device, the available short-circuit current, and the conductor used shall be coordinated to prevent damaging or dangerous temperatures in conductors or conductor insulation under short-circuit conditions.

N 245.27 Additional Requirements for Feeders.

N (A) Rating or Setting of Overcurrent Protective Devices. The continuous ampere rating of a fuse shall not exceed three times the ampacity of the conductors. The long-time trip element setting of a breaker or the minimum trip setting of an electronically actuated fuse shall not exceed six times the ampacity of the conductor. For fire pumps, conductors shall be permitted to be protected for overcurrent in accordance with 695.4(B) (2).

N (B) Feeder Taps. Conductors tapped to a feeder shall be permitted to be protected by the feeder overcurrent device where that overcurrent device also protects the tap conductor.

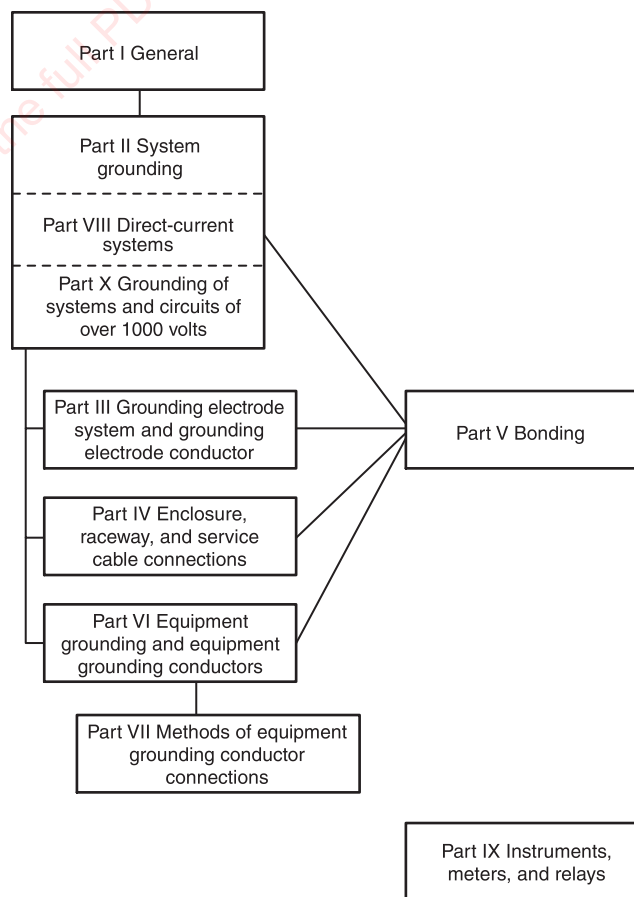
ARTICLE 250 Grounding and Bonding

Part I. General

Δ 250.1 Scope. This article covers general requirements for grounding and bonding of electrical installations and the following specific requirements:

- (1) Systems, circuits, and equipment required, permitted, or not permitted to be grounded
- (2) Circuit conductor to be grounded on grounded systems
- (3) Location of grounding connections
- (4) Types and sizes of grounding and bonding conductors and electrodes
- (5) Methods of grounding and bonding
- (6) Conditions under which isolation, insulation, or guards are permitted to be substituted for grounding

Informational Note: See Informational Note Figure 250.1 for information on the organization of this article covering grounding and bonding requirements.



Informational Note Figure 250.1 Grounding and Bonding.

250.4 General Requirements for Grounding and Bonding.

The following general requirements identify what grounding and bonding of electrical systems are required to accomplish. The prescriptive methods contained in this article shall be followed to comply with the performance requirements of this section.

(A) Grounded Systems.

(1) Electrical System Grounding. Electrical systems that are grounded shall be connected to earth in a manner that will limit the voltage imposed by lightning, line surges, or unintentional contact with higher-voltage lines and that will stabilize the voltage to earth during normal operation.

Informational Note No. 1: An important consideration for limiting the imposed voltage is the routing of bonding and grounding electrode conductors so that they are not any longer than necessary to complete the connection without disturbing the permanent parts of the installation and so that unnecessary bends and loops are avoided.

Informational Note No. 2: See NFPA 780-2020, *Standard for the Installation of Lightning Protection Systems*, for information on installation of grounding and bonding for lightning protection systems.

(2) Grounding of Electrical Equipment. Normally non-current-carrying conductive materials enclosing electrical conductors or equipment, or forming part of such equipment, shall be connected to earth so as to limit the voltage to ground on these materials.

(3) Bonding of Electrical Equipment. Normally non-current-carrying conductive materials enclosing electrical conductors or equipment, or forming part of such equipment, shall be connected together and to the electrical supply source in a manner that establishes an effective ground-fault current path.

(4) Bonding of Electrically Conductive Materials and Other Equipment. Normally non-current-carrying electrically conductive materials that are likely to become energized shall be connected together and to the electrical supply source in a manner that establishes an effective ground-fault current path.

Δ (5) Effective Ground-Fault Current Path. Electrical equipment and wiring and other electrically conductive material likely to become energized shall be installed in a manner that creates a low-impedance circuit facilitating the operation of the overcurrent device or ground detector for impedance grounded systems. It shall be capable of safely carrying the maximum ground-fault current likely to be imposed on it from any point on the wiring system where a ground fault occurs to the electrical supply source. The earth shall not be considered as an effective ground-fault current path.

(B) Ungrounded Systems.

(1) Grounding Electrical Equipment. Non-current-carrying conductive materials enclosing electrical conductors or equipment, or forming part of such equipment, shall be connected to earth in a manner that will limit the voltage imposed by lightning or unintentional contact with higher-voltage lines and limit the voltage to ground on these materials.

Informational Note: See NFPA 780-2020, *Standard for the Installation of Lightning Protection Systems*, for information on installation of grounding and bonding for lightning protection systems.

(2) Bonding of Electrical Equipment. Non-current-carrying conductive materials enclosing electrical conductors or equip-

ment, or forming part of such equipment, shall be connected together and to the supply system grounded equipment in a manner that creates a low-impedance path for ground-fault current that is capable of carrying the maximum fault current likely to be imposed on it.

(3) Bonding of Electrically Conductive Materials and Other Equipment. Electrically conductive materials that are likely to become energized shall be connected together and to the supply system grounded equipment in a manner that creates a low-impedance path for ground-fault current that is capable of carrying the maximum fault current likely to be imposed on it.

(4) Path for Fault Current. Electrical equipment, wiring, and other electrically conductive material likely to become energized shall be installed in a manner that creates a low-impedance circuit from any point on the wiring system to the electrical supply source to facilitate the operation of overcurrent devices should a second ground fault from a different phase occur on the wiring system. The earth shall not be considered as an effective fault-current path.

250.6 Objectionable Current.

(A) Arrangement to Prevent Objectionable Current. The grounding and bonding of electrical systems, circuit conductors, surge arresters, surge-protective devices, and conductive normally non-current-carrying metal parts of equipment shall be installed and arranged in a manner that will prevent objectionable current.

Δ (B) Alterations to Stop Objectionable Current. If the use of multiple grounding or bonding connections results in objectionable current and the requirements of 250.4(A)(5) or (B)(4) are met, one or more of the following alterations shall be permitted:

- (1) Discontinue one or more but not all of such grounding or bonding connections.
- (2) Change the locations of the grounding or bonding connections.
- (3) Interrupt the continuity of the conductor or conductive path causing the objectionable current.
- (4) Take other remedial and approved action.

Δ (C) Currents Not Classified as Objectionable Currents. Currents resulting from abnormal conditions such as ground faults, and from currents resulting from required grounding and bonding connections shall not be classified as objectionable current for the purposes specified in 250.6(A) and (B).

(D) Limitations to Permissible Alterations. This section shall not be considered as permitting electronic equipment to be operated on ac systems or branch circuits that are not connected to an equipment grounding conductor as required by this article. Currents that introduce electromagnetic interference or data errors in electronic equipment shall not be considered the objectionable currents addressed in this section.

(E) Isolation of Objectionable Direct-Current from Cathodic Protection Systems. If isolation of objectionable direct currents from a cathodic protection system is required, a listed isolator device shall be permitted in the equipment grounding conductor path to provide an effective return path for ac ground-fault current while blocking the flow of direct currents.

250.8 Connection of Grounding and Bonding Equipment.

(A) **Permitted Methods.** Equipment grounding conductors, grounding electrode conductors, and bonding jumpers shall be connected by one or more of the following means:

- (1) Listed pressure connectors
- (2) Terminal bars
- (3) Pressure connectors listed as grounding and bonding equipment
- (4) Exothermic welding process
- (5) Machine screw-type fasteners that engage not less than two threads or are secured with a nut
- (6) Thread-forming machine screws that engage not less than two threads in the enclosure
- (7) Connections that are part of a listed assembly
- (8) Other listed means

(B) **Methods Not Permitted.** Connection devices or fittings that depend solely on solder shall not be used.

250.10 Protection of Ground Clamps and Fittings. Ground clamps or other fittings exposed to physical damage shall be enclosed in metal, wood, or equivalent protective covering.

Δ **250.12 Clean Surfaces.** Nonconductive coatings (such as paint, lacquer, and enamel) on equipment to be grounded or bonded shall be removed from threads and other contact surfaces to ensure electrical continuity or shall be connected by means of fittings designed to make such removal unnecessary.

Part II. System Grounding

Δ **250.20 Alternating-Current Systems to Be Grounded.** Alternating-current systems shall be grounded in accordance with 250.20(A), (B), (C), or (D), unless prohibited elsewhere in this Code. Other systems shall be permitted to be grounded. If such systems are grounded, they shall comply with the applicable provisions of this article.

Informational Note No. 1: An example of a system permitted to be grounded is a corner-grounded delta transformer connection.

Informational Note No. 2: See 503.155, 517.61, 517.160, 668.10, and 680.23(A)(2) for examples of circuits prohibited to be grounded.

(A) **Alternating-Current Systems of Less Than 50 Volts.** Alternating-current systems of less than 50 volts shall be grounded under any of the following conditions:

- (1) If supplied by transformers, if the transformer supply system exceeds 150 volts to ground
- (2) If supplied by transformers, if the transformer supply system is ungrounded
- (3) If installed outside as overhead conductors

(B) **Alternating-Current Systems of 50 Volts to 1000 Volts.** Alternating-current systems of 50 volts to 1000 volts that supply premises wiring and premises wiring systems shall be grounded under any of the following conditions:

- (1) If the system can be grounded so that the maximum voltage to ground on the ungrounded conductors does not exceed 150 volts
- (2) If the system is 3-phase, 4-wire, wye connected in which the neutral conductor is used as a circuit conductor

- (3) If the system is 3-phase, 4-wire, delta connected in which the midpoint of one phase winding is used as a circuit conductor

Informational Note: See NFPA 70E-2021, *Standard for Electrical Safety in the Workplace*, Annex O, for information on impedance grounding to reduce arc-flash hazards.

(C) **Alternating-Current Systems of over 1000 Volts.** Alternating-current systems supplying mobile or portable equipment shall be grounded in accordance with 250.188. If supplying other than mobile or portable equipment, such systems shall be permitted to be grounded.

Δ (D) **Impedance Grounded Systems.** Impedance grounded systems shall be grounded in accordance with 250.36 or 250.187, as applicable.

250.21 Alternating-Current Systems of 50 Volts to 1000 Volts Not Required to Be Grounded.

Δ (A) **General.** The following ac systems of 50 volts to 1000 volts shall be permitted to be grounded but shall not be required to be grounded:

- (1) Electrical systems used exclusively to supply industrial electric furnaces used for applications such as melting, refining, or tempering
- (2) Separately derived systems used exclusively for rectifiers that supply only adjustable-speed industrial drives
- (3) Separately derived systems supplied by transformers that have a primary voltage rating of 1000 volts or less if all the following conditions are met:
 - a. The system is used exclusively for control circuits.
 - b. The conditions of maintenance and supervision ensure that only qualified persons service the installation.
 - c. Continuity of control power is required.
- (4) Other systems that are not required to be grounded in accordance with 250.20(B)

(B) **Ground Detectors.** Ground detectors shall be installed in accordance with the following:

- (1) Ungrounded ac systems as permitted in 250.21(A)(1) through (A)(4) operating at not less than 120 volts and at 1000 volts or less shall have ground detectors installed on the system.
- (2) The ground detection sensing equipment shall be connected as close as practicable to where the system receives its supply.

(C) **Marking.** Ungrounded systems shall be legibly marked "Caution: Ungrounded System Operating — ____ Volts Between Conductors" at the source or first disconnecting means of the system. The marking shall be of sufficient durability to withstand the environment involved.

250.24 Grounding of Service-Supplied Alternating-Current Systems.

(A) **System Grounding Connections.** A premises wiring system supplied by a grounded ac service shall have a grounding electrode conductor connected to the grounded service conductor, at each service, in accordance with 250.24(A)(1) through (A)(4).

Δ (1) **General.** The grounding electrode conductor connection shall be made at any accessible point from the load end of the overhead service conductors, service drop, underground serv-

ice conductors, or service lateral to the terminal or bus to which the grounded service conductor is connected at the service disconnecting means.

Informational Note: See Article 100 for definitions of *Service Conductors, Overhead*; *Service Conductors, Underground*; *Service Drop*; and *Service Lateral*.

- Δ (2) **Outdoor Transformer.** If the transformer supplying the service is located outside the building, at least one additional grounding connection shall be made from the grounded service conductor to a grounding electrode, either at the transformer or elsewhere outside the building.

Exception: The additional grounding electrode conductor connection shall not be made on impedance grounded systems. Impedance grounded systems shall meet the requirements of 250.36 or 250.187, as applicable.

(3) **Dual-Fed Services.** For services that are dual fed (double ended) in a common enclosure or grouped together in separate enclosures and employing a secondary tie, a single grounding electrode conductor connection to the tie point of the grounded conductor(s) from each power source shall be permitted.

(4) **Main Bonding Jumper as Wire or Busbar.** If the main bonding jumper specified in 250.28 is a wire or busbar and is installed from the grounded conductor terminal bar or bus to the equipment grounding terminal bar or bus in the service equipment, the grounding electrode conductor shall be permitted to be connected to the equipment grounding terminal bar, or bus to which the main bonding jumper is connected.

- N (B) **Load-Side Grounding Connections.** A grounded conductor shall not be connected to normally non-current-carrying metal parts of equipment, to equipment grounding conductor(s), or be reconnected to ground on the load side of the service disconnecting means except as otherwise permitted in this article.

Informational Note: See 250.30 for separately derived systems, 250.32 for connections at separate buildings or structures, and 250.142 for use of the grounded circuit conductor for grounding equipment.

- Δ (C) **Main Bonding Jumper.** For a grounded system, an unspliced main bonding jumper shall be used to connect the equipment grounding conductor(s) and the service-disconnect enclosure to the grounded conductor within the enclosure for each service disconnect in accordance with 250.28.

Exception No. 1: If more than one service disconnecting means is located in an assembly listed for use as service equipment, an unspliced main bonding jumper shall bond the grounded conductor(s) to the assembly enclosure.

Exception No. 2: Impedance grounded systems shall be permitted to be connected in accordance with 250.36 and 250.187.

- Δ (D) **Grounded Conductor Brought to Service Equipment.** If an ac system operating at 1000 volts or less is grounded at any point, the grounded conductor(s) shall be routed with the ungrounded conductors to each service disconnecting means and shall be connected to each disconnecting means grounded conductor(s) terminal or bus. A main bonding jumper shall connect the grounded conductor(s) to each service disconnecting means enclosure. The grounded conductor(s) shall be

installed in accordance with 250.24(C)(1) and 250.24(D)(1) through (D)(4).

Exception: If two or more service disconnecting means are located in a single assembly listed for use as service equipment, it shall be permitted to connect the grounded conductor(s) to the assembly common grounded conductor(s) terminal or bus. The assembly shall include a main bonding jumper for connecting the grounded conductor(s) to the assembly enclosure.

(1) **Sizing for a Single Raceway or Cable.** The grounded conductor shall not be smaller than specified in Table 250.102(C)(1).

- Δ (2) **Conductors Connected in Parallel in Two or More Raceways or Cables.** If the ungrounded service-entrance conductors are connected in parallel in two or more raceways or cables, the grounded conductors shall also be installed in each raceway or cable and shall be connected in parallel. The size of each grounded conductor(s) in each raceway or cable shall not be smaller than 1/0 AWG and shall be sized in accordance with 250.24(D)(2)(a) or (D)(2)(b) in accordance with 250.24(D)(1).

(a) Shall be based on the largest ungrounded conductor in each raceway or cable.

(b) Shall be based on the sum of the circular mil areas of the largest ungrounded conductors from each set connected in parallel in each raceway or cable.

Informational Note: See 310.10(G) for grounded conductors connected in parallel.

(3) **Delta-Connected Service.** The grounded conductor of a 3-phase, 3-wire delta service shall have an ampacity not less than that of the ungrounded conductors.

- Δ (4) **Impedance Grounded Service.** The impedance grounding conductor on an impedance grounded system shall be connected in accordance with 250.36 or 250.187, as applicable.

(E) **Grounding Electrode Conductor.** A grounding electrode conductor shall be used to connect the equipment grounding conductors, the service-equipment enclosures, and, if the system is grounded, the grounded service conductor to the grounding electrode(s) required by Part III of this article. This conductor shall be sized in accordance with 250.66.

Impedance grounded system connections shall be made in accordance with 250.36 or 250.187, as applicable.

(F) **Ungrounded System Grounding Connections.** A premises wiring system that is supplied by an ac service that is ungrounded shall have, at each service, a grounding electrode conductor connected to the grounding electrode(s) required by Part III of this article. The grounding electrode conductor shall be connected to a metal enclosure of the service conductors at any accessible point from the load end of the overhead service conductors, service drop, underground service conductors, or service lateral to the service disconnecting means.

250.25 Grounding of Systems Permitted to Be Connected on the Supply Side of the Service Disconnect. The grounding of systems connected on the supply side of the service disconnect, in accordance with 230.82, that are in enclosures separate from the service equipment enclosure shall comply with 250.25(A) or (B).

(A) **Grounded System.** If the utility supply system is grounded, the grounding of systems permitted to be connected on the

supply side of the service disconnect and are installed in one or more separate enclosures from the service equipment enclosure shall comply with the requirements of 250.24(A) through (D).

(B) Ungrounded Systems. If the utility supply system is ungrounded, the grounding of systems permitted to be connected on the supply side of the service disconnect and are installed in one or more separate enclosures from the service equipment enclosure shall comply with the requirements of 250.24(F).

250.26 Conductor to Be Grounded — Alternating-Current Systems. If an ac premises wiring system is grounded, the conductor to be grounded shall be one of the following:

- (1) Single-phase, 2-wire — one conductor
- (2) Single-phase, 3-wire — the neutral conductor
- (3) Multiphase systems having one wire common to all phases — the neutral conductor
- (4) Multiphase systems if one phase is grounded — that phase conductor
- (5) Multiphase systems in which one phase is used as in (2) — the neutral conductor

250.28 Main Bonding Jumper and System Bonding Jumper. For a grounded system, main bonding jumpers and system bonding jumpers shall be installed as follows:

(A) Material. Main bonding jumpers and system bonding jumpers shall be of copper, aluminum, copper-clad aluminum, or other corrosion-resistant material. A main bonding jumper and a system bonding jumper shall be a wire, bus, screw, or similar suitable conductor.

(B) Construction. If a main bonding jumper or a system bonding jumper is a screw only, the screw shall be identified with a green finish that shall be visible with the screw installed.

(C) Attachment. Main bonding jumpers and system bonding jumpers shall be connected by one or more of the methods in 250.8 that is suitable for the material of the bonding jumper and enclosure.

(D) Size. Main bonding jumpers and system bonding jumpers shall be sized in accordance with 250.28(D)(1) through (D)(3).

(1) General. Main bonding jumpers and system bonding jumpers shall not be smaller than specified in Table 250.102(C)(1).

(2) Main Bonding Jumper for Service with More Than One Enclosure. If a service consists of more than a single enclosure as permitted in 230.71(B), the main bonding jumper for each enclosure shall be sized in accordance with 250.28(D)(1) based on the largest ungrounded service conductor serving that enclosure.

(3) Separately Derived System with More Than One Enclosure. If a separately derived system supplies more than a single enclosure, the system bonding jumper for each enclosure shall be sized in accordance with 250.28(D)(1) based on the largest ungrounded feeder conductor serving that enclosure, or a single system bonding jumper shall be installed at the source and sized in accordance with 250.28(D)(1) based on the equivalent size of the largest supply conductor determined by the largest sum of the areas of the corresponding conductors of each set.

Δ 250.30 Grounding Separately Derived Alternating-Current Systems. In addition to complying with 250.30(A) for grounded systems, or as provided in 250.30(B) for ungrounded systems, separately derived systems shall comply with 250.20, 250.21, or 250.26, as applicable. Multiple power sources of the same type that are connected in parallel to form one system that supplies premises wiring shall be treated as a single separately derived system and shall be installed in accordance with 250.30.

Informational Note No. 1: An alternate ac power source, such as an on-site generator, is not a separately derived system if the grounded conductor is solidly interconnected to a service-supplied system grounded conductor. An example of such a situation is if the alternate source transfer equipment does not include a switching action in the grounded conductor and allows it to remain solidly connected to the service-supplied grounded conductor when the alternate source is operational and supplying the load served.

Informational Note No. 2: See 445.13 for the minimum size of conductors that carry fault current.

Δ (A) Grounded Systems. A separately derived ac system that is grounded shall comply with 250.30(A)(1) through (A)(8). Except as otherwise permitted in this article, a grounded conductor shall not be connected to normally non-current-carrying metal parts of equipment, be connected to equipment grounding conductors, or be reconnected to ground on the load side of the system bonding jumper.

Informational Note: See 250.32 for connections at separate buildings or structures and 250.142 for use of the grounded circuit conductor for grounding equipment.

Exception: Impedance grounded system grounding connections shall be made in accordance with 250.36 or 250.187, as applicable.

(1) System Bonding Jumper. An unspliced system bonding jumper shall comply with 250.28(A) through (D). This connection shall be made at any single point on the separately derived system from the source to the first system disconnecting means or overcurrent device, or it shall be made at the source of a separately derived system that has no disconnecting means or overcurrent devices, in accordance with 250.30(A)(1)(a) or (A)(1)(b). The system bonding jumper shall remain within the enclosure where it originates. If the source is located outside the building or structure supplied, a system bonding jumper shall be installed at the grounding electrode connection in compliance with 250.30(C).

Exception No. 1: For systems installed in accordance with 450.6, a single system bonding jumper connection to the tie point of the grounded circuit conductors from each power source shall be permitted.

Exception No. 2: If a building or structure is supplied by a feeder from an outdoor separately derived system, a system bonding jumper at both the source and the first disconnecting means shall be permitted if doing so does not establish a parallel path for the grounded conductor. If a grounded conductor is used in this manner, it shall not be smaller than the size specified for the system bonding jumper but shall not be required to be larger than the ungrounded conductor(s). For the purposes of this exception, connection through the earth shall not be considered as providing a parallel path.

Exception No. 3: The size of the system bonding jumper for a system that supplies a Class 1, Class 2, or Class 3 circuit, and is derived from a transformer rated not more than 1000 volt-amperes, shall not be smaller than the derived ungrounded conductors and shall not be smaller than 14 AWG copper or 12 AWG aluminum.

(a) *Installed at the Source.* The system bonding jumper shall connect the grounded conductor to the supply-side bonding jumper and the normally non-current-carrying metal enclosure.

(b) *Installed at the First Disconnecting Means.* The system bonding jumper shall connect the grounded conductor to the supply-side bonding jumper, the disconnecting means enclosure, and the equipment grounding conductor(s).

Exception: Separately derived systems consisting of multiple sources of the same type that are connected in parallel shall be permitted to have the system bonding jumper installed at the paralleling switchgear, switchboard, or other paralleling connection point instead of at the disconnecting means located at each separate source.

(2) Supply-Side Bonding Jumper. If the source of a separately derived system and the first disconnecting means are located in separate enclosures, a supply-side bonding jumper shall be installed with the circuit conductors from the source enclosure to the first disconnecting means enclosure. A supply-side bonding jumper shall not be required to be larger than the derived ungrounded conductors. The supply-side bonding jumper shall be permitted to be of nonflexible metal raceway type or of the wire or bus type as follows:

- (1) A supply-side bonding jumper of the wire type shall comply with 250.102(C), based on the size of the derived ungrounded conductors.
- (2) A supply-side bonding jumper of the bus type shall have a cross-sectional area not smaller than a supply-side bonding jumper of the wire type as determined in 250.102(C).

Exception: A supply-side bonding jumper shall not be required between enclosures for installations made in compliance with 250.30(A)(1), Exception No. 2.

Δ (3) Grounded Conductor. If a grounded conductor is installed and the system bonding jumper connection is not located at the source, 250.30(A)(3)(a) through (A)(3)(d) shall apply. The grounded conductor shall not be required to be larger than the derived ungrounded conductors.

(a) *Sizing for a Single Raceway.* The grounded conductor shall not be smaller than specified in Table 250.102(C)(1).

(b) *Conductors Connected in Parallel in Two or More Raceways or Cables.* If the ungrounded conductors are connected in parallel in two or more raceways or cables, the grounded conductors shall also be installed in each raceway or cable and shall be connected in parallel. The size of the grounded conductor(s) in each raceway or cable shall be based on the largest derived ungrounded conductor in each raceway or cable, or the sum of the circular mil areas of the largest derived ungrounded conductors from each set connected in parallel in each raceway or cable, in accordance with 250.30(A)(3)(a), but not smaller than 1/0 AWG.

Informational Note: See 310.10(G) for grounded conductors connected in parallel.

(c) *Delta-Connected System.* The grounded conductor of a 3-phase, 3-wire delta system shall have an ampacity not less than that of the ungrounded conductors.

(d) *Impedance Grounded System.* The impedance grounding conductor of an impedance grounded system shall be installed in accordance with 250.36 or 250.187, as applicable.

(4) Grounding Electrode. The building or structure grounding electrode system shall be used as the grounding electrode

for the separately derived system. If located outdoors, the grounding electrode shall be in accordance with 250.30(C).

Exception: If a separately derived system originates in equipment that is listed and identified as suitable for use as service equipment, the grounding electrode used for the service or feeder equipment shall be permitted to be used as the grounding electrode for the separately derived system.

Informational Note No. 1: See 250.104(D) for bonding requirements for interior metal water piping in the area served by separately derived systems.

Informational Note No. 2: See 250.50 and 250.58 for requirements for bonding all electrodes together if located at the same building or structure.

(5) Grounding Electrode Conductor, Single Separately Derived System. A grounding electrode conductor for a single separately derived system shall be sized in accordance with 250.66 for the derived ungrounded conductors. It shall be used to connect the grounded conductor of the derived system to the grounding electrode in accordance with 250.30(A)(4), or as permitted in 250.68(C)(1) and (C)(2). This connection shall be made at the same point on the separately derived system where the system bonding jumper is connected.

Exception No. 1: If the system bonding jumper specified in 250.30(A)(1) is a wire or busbar, it shall be permitted to connect the grounding electrode conductor to the equipment grounding terminal, bar, or bus if the equipment grounding terminal, bar, or bus is of sufficient size for the separately derived system.

Exception No. 2: If the source of a separately derived system is located within equipment listed and identified as suitable for use as service equipment, the grounding electrode conductor from the service or feeder equipment to the grounding electrode shall be permitted as the grounding electrode conductor for the separately derived system, if the grounding electrode conductor is of sufficient size for the separately derived system. If the equipment grounding bus internal to the equipment is not smaller than the required grounding electrode conductor for the separately derived system, the grounding electrode connection for the separately derived system shall be permitted to be made to the bus.

Exception No. 3: A grounding electrode conductor shall not be required for a system that supplies a Class 1, Class 2, or Class 3 circuit and is derived from a transformer rated not more than 1000 volt-amperes, provided the grounded conductor is bonded to the transformer frame or enclosure by a jumper sized in accordance with 250.30(A)(1), Exception No. 3, and the transformer frame or enclosure is grounded by one of the means specified in 250.134.

(6) Grounding Electrode Conductor, Multiple Separately Derived Systems. A common grounding electrode conductor for multiple separately derived systems shall be permitted. If installed, the common grounding electrode conductor shall be used to connect the grounded conductor of each separately derived system to the grounding electrode as specified in 250.30(A)(4). A grounding electrode conductor tap shall then be installed from each separately derived system to the common grounding electrode conductor. Each tap conductor shall connect the grounded conductor of the separately derived system to the common grounding electrode conductor. This connection shall be made at the same point on the separately derived system where the system bonding jumper is connected.

Exception No. 1: If the system bonding jumper specified in 250.30(A)(1) is a wire or busbar, it shall be permitted to connect the grounding

electrode conductor tap to the equipment grounding terminal, bar, or bus, provided the equipment grounding terminal, bar, or bus is of sufficient size for the separately derived system.

Exception No. 2: A grounding electrode conductor shall not be required for a system that supplies a Class 1, Class 2, or Class 3 circuit and is derived from a transformer rated not more than 1000 volt-amperes, provided the system grounded conductor is bonded to the transformer frame or enclosure by a jumper sized in accordance with 250.30(A)(1), *Exception No. 3*, and the transformer frame or enclosure is grounded by one of the means specified in 250.134.

Exception No. 3: If the source of a separately derived system is located within equipment listed and identified as suitable for use as service equipment, the grounding electrode conductor from the service or feeder equipment to the grounding electrode shall be permitted as the grounding electrode conductor for the separately derived system, if the grounding electrode conductor is of sufficient size for the separately derived system. If the equipment grounding bus internal to the equipment is not smaller than the required grounding electrode conductor for the separately derived system, the grounding electrode connection for the separately derived system shall be permitted to be made to the bus.

(a) **Common Grounding Electrode Conductor.** The common grounding electrode conductor shall be permitted to be one of the following:

- (1) A conductor of the wire type not smaller than 3/0 AWG copper or 250 kcmil aluminum
- (2) A metal water pipe in accordance with 250.68(C)(1)
- (3) The metal structural frame of the building or structure in accordance with 250.68(C)(2) or is connected to the grounding electrode system by a conductor not smaller than 3/0 AWG copper or 250 kcmil aluminum

(b) **Tap Conductor Size.** Each tap conductor shall be sized in accordance with 250.66 based on the derived ungrounded conductors of the separately derived system it serves.

Exception to (a)(1) and (b): If the only electrodes that are present are of the types in 250.66(A), (B), or (C), the size of the common grounding electrode conductor shall not be required to be larger than the largest conductor required by 250.66(A), (B), or (C) for the type of electrode that is present.

(c) **Connections.** All tap connections to the common grounding electrode conductor shall be made at an accessible location by one of the following methods:

- (1) A connector listed as grounding and bonding equipment.
- (2) Listed connections to aluminum or copper busbars not smaller than 6 mm thick $\times$ 50 mm wide ($\frac{1}{4}$ in. thick $\times$ 2 in. wide) and of a length to accommodate the number of terminations necessary for the installation. If aluminum busbars are used, the installation shall also be in accordance with 250.64(A).
- (3) The exothermic welding process.

Tap conductors shall be connected to the common grounding electrode conductor in such a manner that the common grounding electrode conductor remains without a splice or joint.

(7) **Installation.** The installation of all grounding electrode conductors shall comply with 250.64(A), (B), (C), and (E).

(8) **Bonding.** Structural steel and metal piping shall be connected to the grounded conductor of a separately derived system in accordance with 250.104(D).

(B) **Ungrounded Systems.** The equipment of an ungrounded separately derived system shall be grounded and bonded as specified in 250.30(B)(1) through (B)(3).

(1) **Grounding Electrode Conductor.** A grounding electrode conductor, sized in accordance with 250.66 for the largest derived ungrounded conductor(s) or set of derived ungrounded conductors, shall be used to connect the metal enclosures of the derived system to the grounding electrode as specified in 250.30(A)(5) or (A)(6), as applicable. This connection shall be made at any point on the separately derived system from the source to the first system disconnecting means. If the source is located outside the building or structure supplied, a grounding electrode connection shall be made in compliance with 250.30(C).

(2) **Grounding Electrode.** Except as permitted by 250.34 for portable and vehicle-mounted generators, the grounding electrode shall comply with 250.30(A)(4).

(3) **Bonding Path and Conductor.** A supply-side bonding jumper shall be installed from the source of a separately derived system to the first disconnecting means in compliance with 250.30(A)(2).

Δ (C) **Outdoor Source.** If the source of the separately derived system is located outside the building or structure supplied, a grounding electrode connection shall be made at the source location to one or more grounding electrodes in accordance with 250.50. In addition, the installation shall be in accordance with 250.30(A) for grounded systems or with 250.30(B) for ungrounded systems.

Exception: The grounding electrode conductor connection for impedance grounded systems shall be in accordance with 250.36 or 250.187, as applicable.

250.32 Buildings or Structures Supplied by a Feeder(s) or Branch Circuit(s).

Δ (A) **Grounding Electrode System and Grounding Electrode Conductor.** A building(s) or structure(s) supplied by a feeder(s) or branch circuit(s) shall have a grounding electrode system and grounding electrode conductor installed in accordance with Part III of Article 250.

Exception: A grounding electrode system and grounding electrode conductor shall not be required if only a single branch circuit, including a multiwire branch circuit, supplies the building or structure and the branch circuit includes an equipment grounding conductor for grounding the normally non-current-carrying metal parts of equipment.

(B) Grounded Systems.

(1) **Supplied by a Feeder or Branch Circuit.** An equipment grounding conductor, as described in 250.118, shall be run with the supply conductors and be connected to the building or structure disconnecting means and to the grounding electrode(s). The equipment grounding conductor shall be used for grounding or bonding of equipment, structures, or frames required to be grounded or bonded. The equipment grounding conductor shall be sized in accordance with 250.122. Any installed grounded conductor shall not be connected to the equipment grounding conductor or to the grounding electrode(s).

Exception No. 1: For installations made in compliance with previous editions of this Code that permitted such connection, the grounded conductor run with the supply to the building or structure shall be

permitted to serve as the ground-fault return path if all of the following requirements continue to be met:

- (1) An equipment grounding conductor is not run with the supply to the building or structure.
- (2) There are no continuous metallic paths bonded to the grounding system in each building or structure involved.
- (3) Ground-fault protection of equipment has not been installed on the supply side of the feeder(s).

If the grounded conductor is used for grounding in accordance with the provision of this exception, the size of the grounded conductor shall not be smaller than the larger of either of the following:

- (1) The calculated neutral load in accordance with 220.61
- (2) The minimum equipment grounding conductor sized in accordance with 250.122

Exception No. 2: If system bonding jumpers are installed in accordance with 250.30(A)(1), Exception No. 2, the feeder grounded circuit conductor at the building or structure served shall be connected to the equipment grounding conductors, grounding electrode conductor, and the enclosure for the first disconnecting means.

(2) Supplied by Separately Derived System.

(a) *With Overcurrent Protection.* If overcurrent protection is provided where the conductors originate, the installation shall comply with 250.32(B)(1).

(b) *Without Overcurrent Protection.* If overcurrent protection is not provided where the conductors originate, the installation shall comply with 250.30(A). If installed, the supply-side bonding jumper shall be connected to the building or structure disconnecting means and to the grounding electrode(s).

(C) Ungrounded Systems.

(1) **Supplied by a Feeder or Branch Circuit.** An equipment grounding conductor, as described in 250.118, shall be installed with the supply conductors and be connected to the building or structure disconnecting means and to the grounding electrode(s). The grounding electrode(s) shall also be connected to the building or structure disconnecting means.

(2) Supplied by a Separately Derived System.

(a) *With Overcurrent Protection.* If overcurrent protection is provided where the conductors originate, the installation shall comply with 250.32(C)(1).

(b) *Without Overcurrent Protection.* If overcurrent protection is not provided where the conductors originate, the installation shall comply with 250.30(B). If installed, the supply-side bonding jumper shall be connected to the building or structure disconnecting means and to the grounding electrode(s).

(D) Disconnecting Means Located in Separate Building or Structure on the Same Premises. If one or more disconnecting means supply one or more additional buildings or structures under single management, and where these disconnecting means are located remote from those buildings or structures in accordance with 225.31(B), Exception No. 1 and No. 2, 700.12(D)(4), 701.12(D)(3), or 702.12, all of the following conditions shall be met:

- (1) The connection of the grounded conductor to the grounding electrode, to normally non-current-carrying metal parts of equipment, or to the equipment grounding conductor at a separate building or structure shall not be made.
- (2) An equipment grounding conductor for grounding and bonding any normally non-current-carrying metal parts of

equipment, interior metal piping systems, and building or structural metal frames is run with the circuit conductors to a separate building or structure and connected to existing grounding electrode(s) required in Part III of this article, or, if there are no existing electrodes, the grounding electrode(s) required in Part III of this article shall be installed if a separate building or structure is supplied by more than one branch circuit.

- (3) The connection between the equipment grounding conductor and the grounding electrode at a separate building or structure shall be made in a junction box, panelboard, or similar enclosure located immediately inside or outside the separate building or structure.

(E) Grounding Electrode Conductor. The size of the grounding electrode conductor to the grounding electrode(s) shall not be smaller than given in 250.66, based on the largest ungrounded supply conductor. The installation shall comply with Part III of this article.

250.34 Portable, Vehicle-Mounted, and Trailer-Mounted Generators.

(A) Portable Generators. The frame of a portable generator shall not be required to be connected to a grounding electrode as defined in 250.52 for a system supplied by the generator under both of the following conditions:

- (1) The generator supplies only equipment mounted on the generator, cord-and-plug-connected equipment through receptacles mounted on the generator, or both.
- (2) The normally non-current-carrying metal parts of equipment and the equipment grounding conductor terminals of the receptacles are connected to the generator frame.

(B) Vehicle-Mounted and Trailer-Mounted Generators. The frame of a vehicle or trailer shall not be required to be connected to a grounding electrode as defined in 250.52 for a system supplied by a generator located on this vehicle or trailer under all of the following conditions:

- (1) The frame of the generator is bonded to the vehicle or trailer frame.
- (2) The generator supplies only equipment located on the vehicle or trailer; cord-and-plug-connected equipment through receptacles mounted on the vehicle; or both equipment located on the vehicle or trailer and cord-and-plug-connected equipment through receptacles mounted on the vehicle, trailer, or on the generator.
- (3) The normally non-current-carrying metal parts of equipment and the equipment grounding conductor terminals of the receptacles are connected to the generator frame.

Δ (C) Grounded Conductor Bonding. A conductor that is required to be grounded by 250.26 shall be connected to the generator frame if the generator is a component of a separately derived system.

Informational Note: See 250.30 for grounding portable generators supplying fixed wiring systems.

250.35 Permanently Installed Generators. A conductor that provides an effective ground-fault current path shall be installed with the supply conductors from a permanently installed generator(s) to the first disconnecting mean(s) in accordance with 250.35(A) or (B).

(A) Separately Derived System. If the generator is installed as a separately derived system, the requirements in 250.30 shall apply.

(B) Nonseparately Derived System. If the generator is installed as a nonseparately derived system, and overcurrent protection is not integral with the generator assembly, a supply-side bonding jumper shall be installed between the generator equipment grounding terminal and the equipment grounding terminal, bar, or bus of the disconnecting mean(s). It shall be sized in accordance with 250.102(C) based on the size of the conductors supplied by the generator.

Δ 250.36 Impedance Grounded Systems — 480 Volts to 1000 Volts. Impedance grounded systems in which a grounding impedance device, typically a resistor, limits the ground-fault current shall be permitted for 3-phase ac systems of 480 volts to 1000 volts if all the following conditions are met:

- (1) The conditions of maintenance and supervision ensure that only qualified persons service the installation.
- (2) Ground detectors are installed on the system.
- (3) Line-to-neutral loads are not served.

Impedance grounded systems shall comply with 250.36(A) through (G).

Informational Note: See NFPA 70E-2021, *Standard for Electrical Safety in the Workplace*, Annex O, for information on impedance grounding to reduce arc-flash hazards.

(A) Location. The grounding impedance device shall be installed between the grounding electrode conductor and the impedance grounding conductor connected to the system neutral point. If a neutral point is not available, the grounding impedance shall be installed between the grounding electrode conductor and the impedance grounding conductor connected to the neutral point derived from a grounding transformer.

(B) Impedance Grounding Conductor Insulation and Ampacity. The impedance grounding conductor from the neutral point of the transformer or generator to its connection point to the grounding impedance shall be fully insulated.

The impedance grounding conductor shall have an ampacity of not less than the maximum current rating of the grounding impedance but in no case shall the impedance grounding conductor be smaller than 8 AWG copper or 6 AWG aluminum or copper-clad aluminum.

(C) System Grounding Connection. The system shall not be connected to ground except through the grounding impedance device.

Informational Note: The impedance is normally selected to limit the ground-fault current to a value slightly greater than or equal to the capacitive charging current of the system. This value of impedance will also limit transient overvoltages to safe values. For guidance, refer to criteria for limiting transient overvoltages in IEEE 3003.1-2019, *Recommended Practice for System Grounding of Industrial and Commercial Power Systems*.

(D) Impedance Grounding Conductor Routing. The impedance grounding conductor shall be permitted to be installed in a separate raceway from the ungrounded conductors. It shall not be required to run this conductor with the phase conductors to the first system disconnecting means or overcurrent device.

(E) Impedance Bonding Jumper. The impedance bonding jumper (the connection between the equipment grounding

conductors and the grounding impedance device) shall be an unspliced conductor run from the first system disconnecting means or overcurrent device to the grounded side of the grounding impedance device.

(F) Grounding Electrode Conductor Connection Location. For services or separately derived systems, the grounding electrode conductor shall be connected at any point from the grounded side of the grounding impedance device to the equipment grounding connection at the service equipment or the first system disconnecting means of a separately derived system.

(G) Impedance Bonding Jumper Size. The impedance bonding jumper shall be sized in accordance with either of the following:

- (1) If the grounding electrode conductor connection is made at the grounding impedance device, the equipment bonding jumper shall be sized in accordance with 250.66, based on the size of the service entrance conductors for a service or the derived phase conductors for a separately derived system.
- (2) If the grounding electrode conductor is connected at the first system disconnecting means or overcurrent device, the impedance bonding jumper shall be sized the same as the impedance grounding conductor in 250.36(B).

Part III. Grounding Electrode System and Grounding Electrode Conductor

250.50 Grounding Electrode System. All grounding electrodes as described in 250.52(A)(1) through (A)(7) that are present at each building or structure served shall be bonded together to form the grounding electrode system. If none of these grounding electrodes exist, one or more of the grounding electrodes specified in 250.52(A)(4) through (A)(8) shall be installed and used.

Exception: Concrete-encased electrodes of existing buildings or structures shall not be required to be part of the grounding electrode system if the rebar is not accessible for use without disturbing the concrete.

250.52 Grounding Electrodes.

(A) Electrodes Permitted for Grounding.

(1) Metal Underground Water Pipe. A metal underground water pipe in direct contact with the earth for 3.0 m (10 ft) or more (including any metal well casing bonded to the pipe) and electrically continuous (or made electrically continuous by bonding around insulating joints or insulating pipe) to the points of connection of the grounding electrode conductor and the bonding conductor(s) or jumper(s), if installed.

(2) Metal In-ground Support Structure(s). One or more metal in-ground support structure(s) in direct contact with the earth vertically for 3.0 m (10 ft) or more, with or without concrete encasement. If multiple metal in-ground support structures are present at a building or a structure, it shall be permissible to bond only one into the grounding electrode system.

Informational Note: Metal in-ground support structures include, but are not limited to, pilings, casings, and other structural metal.

Δ (3) Concrete-Encased Electrode. A concrete-encased electrode shall consist of at least 6.0 m (20 ft) of either of the following:

- (1) One or more bare or zinc galvanized or other electrically conductive coated rebar of not less than 13 mm (½ in.) in diameter, installed in one continuous 6.0 m (20 ft) length, or if in multiple pieces, the rebar shall be connected together by steel tie wires, exothermic welding, welding, or other effective means to create a 6.0 m (20 ft) or greater length
- (2) Bare copper conductor not smaller than 4 AWG

Metal components shall be encased by at least 50 mm (2 in.) of concrete and shall be located horizontally within that portion of a concrete foundation or footing that is in direct contact with the earth or within vertical foundations or structural components or members that are in direct contact with the earth. If multiple concrete-encased electrodes are present at a building or structure, it shall be permissible to bond only one into the grounding electrode system.

Informational Note: Concrete installed with insulation, vapor barriers, films, or similar items separating the concrete from the earth is not considered to be in “direct contact” with the earth.

(4) Ground Ring. A ground ring encircling the building or structure, in direct contact with the earth, consisting of at least 6.0 m (20 ft) of bare copper conductor not smaller than 2 AWG.

Δ (5) Rod and Pipe Electrodes. Rod and pipe electrodes shall not be less than 2.44 m (8 ft) in length and consist of the following materials.

- (1) Grounding electrodes of pipe or conduit shall not be smaller than metric designator 21 (trade size ¾) and, where of steel, shall have the outer surface galvanized or otherwise metal-coated for corrosion protection.
- (2) Rod-type grounding electrodes of stainless steel and copper or zinc-coated steel shall be at least 15.87 mm (⅝ in.) in diameter, unless listed.

(6) Other Listed Electrodes. Other listed grounding electrodes shall be permitted.

(7) Plate Electrodes. Each plate electrode shall expose not less than 0.186 m² (2 ft²) of surface to exterior soil. Electrodes of bare or electrically conductive coated iron or steel plates shall be at least 6.4 mm (¼ in.) in thickness. Solid, uncoated electrodes of nonferrous metal shall be at least 1.5 mm (0.06 in.) in thickness.

(8) Other Local Metal Underground Systems or Structures. Other local metal underground systems or structures such as piping systems, underground tanks, and underground metal well casings that are not bonded to a metal water pipe.

(B) Not Permitted for Use as Grounding Electrodes. The following systems and materials shall not be used as grounding electrodes:

- (1) Metal underground gas piping systems
- (2) Aluminum
- (3) The structures and structural rebar described in 680.26(B)(1) and (B)(2)

Informational Note: See 250.104(B) for bonding requirements of gas piping.

250.53 Grounding Electrode System Installation.

(A) Rod, Pipe, and Plate Electrodes. Rod, pipe, and plate electrodes shall be free from nonconductive coatings such as paint or enamel. Rod, pipe, and plate electrodes shall meet the requirements of 250.53(A)(1) through (A)(3).

Δ (1) Below Permanent Moisture Level. If practicable, rod, pipe, and plate electrodes shall be embedded below permanent moisture level.

(2) Supplemental Electrode Required. A single rod, pipe, or plate electrode shall be supplemented by an additional electrode of a type specified in 250.52(A)(2) through (A)(8). The supplemental electrode shall be permitted to be bonded to one of the following:

- (1) Rod, pipe, or plate electrode
- (2) Grounding electrode conductor
- (3) Grounded service-entrance conductor
- (4) Nonflexible grounded service raceway
- (5) Any grounded service enclosure

Exception: If a single rod, pipe, or plate grounding electrode has a resistance to earth of 25 ohms or less, the supplemental electrode shall not be required.

(3) Supplemental Electrode. If multiple rod, pipe, or plate electrodes are installed to meet the requirements of this section, they shall not be less than 1.8 m (6 ft) apart.

Informational Note: The paralleling efficiency of rods is increased by spacing them twice the length of the longest rod.

(4) Rod and Pipe Electrodes. The electrode shall be installed such that at least 2.44 m (8 ft) of length is in contact with the soil. It shall be driven to a depth of not less than 2.44 m (8 ft) except that, where rock bottom is encountered, the electrode shall be driven at an oblique angle not to exceed 45 degrees from the vertical or, where rock bottom is encountered at an angle up to 45 degrees, the electrode shall be permitted to be buried in a trench that is at least 750 mm (30 in.) deep. The upper end of the electrode shall be flush with or below ground level unless the aboveground end and the grounding electrode conductor attachment are protected against physical damage as specified in 250.10.

(5) Plate Electrode. Plate electrodes shall be installed not less than 750 mm (30 in.) below the surface of the earth.

Δ (B) Electrode Spacing. If more than one of the electrodes of the type specified in 250.52(A)(5) or (A)(7) are used, each electrode of one grounding system (including that used for strike termination devices) shall not be less than 1.83 m (6 ft) from any other electrode of another grounding system.

(C) Bonding Jumper. The bonding jumper(s) used to connect the grounding electrodes together to form the grounding electrode system shall be installed in accordance with 250.64(A), (B), and (E), shall be sized in accordance with 250.66, and shall be connected in the manner specified in 250.70. Rebar shall not be used as a conductor to interconnect the electrodes of grounding electrode systems.

(D) Metal Underground Water Pipe. If used as a grounding electrode, metal underground water pipe shall meet the requirements of 250.53(D)(1) and (D)(2).

(1) **Continuity.** Continuity of the grounding path or the bonding connection to interior piping shall not rely on water meters or filtering devices and similar equipment.

(2) **Supplemental Electrode Required.** A metal underground water pipe shall be supplemented by an additional electrode of a type specified in 250.52(A)(2) through (A)(8). If the supplemental electrode is of the rod, pipe, or plate type, it shall comply with 250.53(A). The supplemental electrode shall be bonded to one of the following:

- (1) Grounding electrode conductor
- (2) Grounded service-entrance conductor
- (3) Nonflexible grounded service raceway
- (4) Any grounded service enclosure
- (5) As provided by 250.32(B)

Exception: The supplemental electrode shall be permitted to be bonded to the interior metal water piping as specified in 250.68(C)(1).

(E) **Supplemental Grounding Electrode Bonding Jumper Size.** If the supplemental electrode is a rod, pipe, or plate electrode, that portion of the bonding jumper that is the sole connection to the supplemental grounding electrode shall not be required to be larger than 6 AWG copper wire or 4 AWG aluminum or copper-clad aluminum wire.

(F) **Ground Ring.** The ground ring shall be installed not less than 750 mm (30 in.) below the surface of the earth.

250.54 Auxiliary Grounding Electrodes. One or more grounding electrodes shall be permitted to be connected to the equipment grounding conductors specified in 250.118 and shall not be required to comply with the electrode bonding requirements of 250.50 or 250.53(C) or the resistance requirements of 250.53(A)(2). *Exception, but the earth shall not be used as an effective ground-fault current path as specified in 250.4(A)(5) and (B)(4).*

Δ 250.58 Common Grounding Electrode. If an ac system is connected to a grounding electrode in or at a building or structure, the same electrode shall be used to ground conductor enclosures and equipment in or on that building or structure. If separate services, feeders, or branch circuits supply a building and are required to be connected to a grounding electrode(s), the same grounding electrode(s) shall be used.

250.60 Use of Strike Termination Devices. Conductors and driven pipes, rods, or plate electrodes used for grounding strike termination devices shall not be used in lieu of the grounding electrodes required by 250.50 for grounding wiring systems and equipment. This provision shall not prohibit the required bonding together of grounding electrodes of different systems.

Informational Note No. 1: See 250.106 for the bonding requirement of the lightning protection system components to the building or structure grounding electrode system.

Informational Note No. 2: Bonding together of all separate grounding electrodes will limit voltage differences between them and between their associated wiring systems.

250.62 Grounding Electrode Conductor Material. The grounding electrode conductor shall be of copper, aluminum, copper-clad aluminum, or the items as permitted in 250.68(C). The material selected shall be resistant to any corrosive condition existing at the installation or shall be protected against corrosion. Conductors of the wire type shall be solid or stranded, insulated, covered, or bare.

250.64 Grounding Electrode Conductor Installation. Grounding electrode conductors at the service, at each building or structure where supplied by a feeder(s) or branch circuit(s), or at a separately derived system shall be installed as specified in 250.64(A) through (G).

(A) **Aluminum or Copper-Clad Aluminum Conductors.** Grounding electrode conductors of bare, covered, or insulated aluminum or copper-clad aluminum shall comply with the following:

- (1) Bare or covered conductors without an extruded polymeric covering shall not be installed where subject to corrosive conditions or be installed in direct contact with concrete.
- (2) Terminations made within outdoor enclosures that are listed and identified for the environment shall be permitted within 450 mm (18 in.) of the bottom of the enclosure.
- (3) Aluminum or copper-clad aluminum conductors external to buildings or equipment enclosures shall not be terminated within 450 mm (18 in.) of the earth.

(B) **Securing and Protection Against Physical Damage.** If exposed, a grounding electrode conductor or its enclosure shall be securely fastened to the surface on which it is carried. Grounding electrode conductors shall be permitted to be installed on or through framing members.

(1) **Not Exposed to Physical Damage.** A 6 AWG or larger copper, copper-clad aluminum, or aluminum grounding electrode conductor not exposed to physical damage shall be permitted to be run along the surface of the building construction without metal covering or protection.

(2) **Exposed to Physical Damage.** A 6 AWG or larger copper, copper-clad aluminum, or aluminum grounding electrode conductor exposed to physical damage shall be protected in rigid metal conduit (RMC), intermediate metal conduit (IMC), Schedule 80 rigid polyvinyl chloride conduit (PVC), reinforced thermosetting resin conduit Type XW (RTRC-XW), electrical metallic tubing (EMT), or cable armor.

(3) **Smaller Than 6 AWG.** Grounding electrode conductors smaller than 6 AWG shall be protected in RMC, IMC, Schedule 80 PVC, RTRC-XW, EMT, or cable armor.

(4) **In Contact with the Earth.** Grounding electrode conductors and grounding electrode bonding jumpers in contact with the earth shall not be required to comply with 300.5 or 305.15, but shall be buried or otherwise protected if subject to physical damage.

(C) **Continuous.** Except as provided in 250.30(A)(5) and (A)(6), 250.30(B)(1), and 250.68(C), grounding electrode conductor(s) shall be installed in one continuous length without a splice or joint. If necessary, splices or connections shall be made as permitted in the following:

- (1) Splicing of the wire-type grounding electrode conductor shall be permitted only by irreversible compression-type connectors listed as grounding and bonding equipment or by the exothermic welding process.
- (2) Sections of busbars shall be permitted to be connected together to form a grounding electrode conductor.
- (3) Bolted, riveted, or welded connections of structural metal frames of buildings or structures.
- (4) Threaded, welded, brazed, soldered or bolted-flange connections of metal water piping.

(D) Building or Structure with Multiple Disconnecting Means in Separate Enclosures. If a building or structure is supplied by a service or feeder with two or more disconnecting means in separate enclosures, the grounding electrode connections shall be made in accordance with 250.64(D)(1), (D)(2), or (D)(3).

(1) Common Grounding Electrode Conductor and Taps. A common grounding electrode conductor and grounding electrode conductor taps shall be installed. The common grounding electrode conductor shall be sized in accordance with 250.66, based on the sum of the circular mil area of the largest ungrounded conductor(s) of each set of conductors that supplies the disconnecting means. If the service-entrance conductors connect directly to the overhead service conductors, service drop, underground service conductors, or service lateral, the common grounding electrode conductor shall be sized in accordance with Table 250.66, note 1.

A grounding electrode conductor tap shall extend to the inside of each disconnecting means enclosure. The grounding electrode conductor taps shall be sized in accordance with 250.66 for the largest service-entrance or feeder conductor serving the individual enclosure. The tap conductors shall be connected to the common grounding electrode conductor by one of the following methods in such a manner that the common grounding electrode conductor remains without a splice or joint:

- (1) Exothermic welding.
- (2) Connectors listed as grounding and bonding equipment.
- (3) Connections to an aluminum or copper busbar not less than 6 mm thick × 50 mm wide (¼ in. thick × 2 in. wide) and of a length to accommodate the number of terminations necessary for the installation. The busbar shall be securely fastened and shall be installed in an accessible location. Connections shall be made by a listed connector or by the exothermic welding process. If aluminum busbars are used, the installation shall comply with 250.64(A).

(2) Individual Grounding Electrode Conductors. A grounding electrode conductor shall be connected between the grounding electrode system and one or more of the following, as applicable:

- (1) Grounded conductor in each service equipment disconnecting means enclosure
- (2) Equipment grounding conductor installed with the feeder(s) or branch circuit(s) for other than services
- (3) Supply-side bonding jumper

Each grounding electrode conductor shall be sized in accordance with 250.66 based on the service-entrance or feeder conductor(s) supplying the individual disconnecting means.

(3) Common Location. A grounding electrode conductor shall be connected in a wireway or other accessible enclosure on the supply side of the disconnecting means to one or more of the following, as applicable:

- (1) Grounded service conductor(s)
- (2) Equipment grounding conductor installed with the feeder
- (3) Supply-side bonding jumper

The connection shall be made with exothermic welding or a connector listed as grounding and bonding equipment. The grounding electrode conductor shall be sized in accordance

with 250.66 based on the service-entrance or feeder conductor(s) at the common location where the connection is made.

(E) Raceways, Cable Armor, and Enclosures for Grounding Electrode Conductors.

(1) General. Ferrous metal raceways, enclosures, and cable armor for grounding electrode conductors shall be electrically continuous from the point of attachment to cabinets or equipment to the grounding electrode and shall be securely fastened to the ground clamp or fitting. Ferrous metal raceways, enclosures, and cable armor shall be bonded at each end of the raceway or enclosure to the grounding electrode or grounding electrode conductor to create an electrically parallel path. Nonferrous metal raceways, enclosures, and cable armor shall not be required to be electrically continuous.

(2) Methods. Bonding shall be in compliance with 250.92(B) and ensured by one of the methods in 250.92(B)(2) through (B)(4).

(3) Size. The bonding jumper for a grounding electrode conductor(s), raceway(s), enclosure(s), or cable armor shall be the same size as, or larger than, the largest enclosed grounding electrode conductor.

(4) Wiring Methods. If a raceway is used as protection for a grounding electrode conductor, the installation shall comply with the requirements of the applicable raceway article.

(F) Installation to Electrode(s). Grounding electrode conductor(s) and bonding jumpers interconnecting grounding electrodes shall be installed in accordance with one of the following. The grounding electrode conductor shall be sized for the largest grounding electrode conductor required among all the electrodes connected to it.

- (1) The grounding electrode conductor shall be permitted to be run to any convenient grounding electrode available in the grounding electrode system where the other electrode(s), if any, is connected by bonding jumpers that are installed in accordance with 250.53(C).
- (2) Grounding electrode conductor(s) shall be permitted to be run to one or more grounding electrode(s) individually.
- (3) Bonding jumper(s) from grounding electrode(s) shall be permitted to be connected to an aluminum or copper busbar not less than 6 mm thick × 50 mm wide (¼ in. thick × 2 in. wide.) and of sufficient length to accommodate the number of terminations necessary for the installation. The busbar shall be securely fastened and shall be installed in an accessible location. Connections shall be made by a listed connector or by the exothermic welding process. The grounding electrode conductor shall be permitted to be run to the busbar. Where aluminum busbars are used, the installation shall comply with 250.64(A).

(G) Enclosures with Ventilation Openings. Grounding electrode conductors shall not be installed through a ventilation opening of an enclosure.

250.66 Size of Alternating-Current Grounding Electrode Conductor. The size of the grounding electrode conductor and bonding jumper(s) for connection of grounding electrodes shall not be smaller than given in Table 250.66, except as permitted in 250.66(A) through (C).

Table 250.66 Grounding Electrode Conductor for Alternating-Current Systems

Size of Largest Ungrounded Conductor or Equivalent Area for Parallel Conductors (AWG/kcmil)		Size of Grounding Electrode Conductor (AWG/kcmil)	
Copper	Aluminum or Copper-Clad Aluminum	Copper	Aluminum or Copper-Clad Aluminum
2 or smaller	1/0 or smaller	8	6
1 or 1/0	2/0 or 3/0	6	4
2/0 or 3/0	4/0 or 250	4	2
Over 3/0 through 350	Over 250 through 500	2	1/0
Over 350 through 600	Over 500 through 900	1/0	3/0
Over 600 through 1100	Over 900 through 1750	2/0	4/0
Over 1100	Over 1750	3/0	250

Notes:

1. If multiple sets of service-entrance conductors connect directly to a service drop, set of overhead service conductors, set of underground service conductors, or service lateral, the equivalent size of the largest service-entrance conductor shall be determined by the largest sum of the areas of the corresponding conductors of each set.
2. If there are no service-entrance conductors, the grounding electrode conductor size shall be determined by the equivalent size of the largest service-entrance conductor required for the load to be served.
3. See installation restrictions in 250.64.

(A) Connections to a Rod, Pipe, or Plate Electrode(s). If the grounding electrode conductor or bonding jumper connected to a single or multiple rod, pipe, or plate electrode(s), or any combination thereof, as described in 250.52(A)(5) or (A)(7), does not extend on to other types of electrodes that require a larger size conductor, the grounding electrode conductor shall not be required to be larger than 6 AWG copper wire or 4 AWG aluminum or copper-clad aluminum wire.

(B) Connections to Concrete-Encased Electrodes. If the grounding electrode conductor or bonding jumper connected to a single or multiple concrete-encased electrode(s), as described in 250.52(A)(3), does not extend on to other types of electrodes that require a larger size of conductor, the grounding electrode conductor shall not be required to be larger than 4 AWG copper wire.

(C) Connections to Ground Rings. If the grounding electrode conductor or bonding jumper connected to a ground ring, as described in 250.52(A)(4), does not extend on to other types of electrodes that require a larger size of conductor, the grounding electrode conductor shall not be required to be larger than the conductor used for the ground ring.

250.68 Grounding Electrode Conductor and Bonding Jumper Connection to Grounding Electrodes. The connection of a grounding electrode conductor at the service, at each building or structure where supplied by a feeder(s) or branch circuit(s), or at a separately derived system and associated bonding jumper(s) shall be made as specified 250.68(A) through (C).

(A) Accessibility. All mechanical elements used to terminate a grounding electrode conductor or bonding jumper to a grounding electrode shall be accessible.

Exception No. 1: An encased or buried connection to a concrete-encased, driven, or buried grounding electrode shall not be required to be accessible.

Exception No. 2: Exothermic or irreversible compression connections used at terminations, together with the mechanical means used to attach such terminations to fireproofed structural metal whether or not the mechanical means is reversible, shall not be required to be accessible.

(B) Effective Grounding Path. The connection of a grounding electrode conductor or bonding jumper to a grounding electrode shall be made in a manner that will ensure an effective grounding path. Where necessary to ensure the grounding path for a metal piping system used as a grounding electrode, bonding shall be provided around insulated joints and around any equipment likely to be disconnected for repairs or replacement. Bonding jumpers shall be of sufficient length to permit removal of such equipment while retaining the integrity of the grounding path.

(C) Grounding Electrode Conductor Connections. Grounding electrode conductors and bonding jumpers shall be permitted to be connected at the following locations and used to extend the connection to an electrode(s):

- (1) Interior metal water piping that is electrically continuous with a metal underground water pipe electrode and is located not more than 1.52 m (5 ft) from the point of entrance to the building, as measured along the water piping, shall be permitted to extend the connection to an electrode(s). Interior metal water piping located more than 1.52 m (5 ft) from the point of entrance to the building, as measured along the water piping, shall not be used as a conductor to interconnect electrodes of the grounding electrode system.

Exception: In industrial, commercial, and institutional buildings or structures, if conditions of maintenance and supervision ensure that only qualified persons service the installation, interior metal water piping located more than 1.52 m (5 ft) from the point of entrance to the building, as measured along the water piping, shall be permitted as a bonding conductor to interconnect electrodes that are part of the grounding electrode system, or as a grounding electrode conductor, if the entire length, other than short sections passing perpendicularly through walls, floors, or ceilings, of the interior metal water pipe that is being used for the conductor is exposed.

- (2) The metal structural frame of a building shall be permitted to be used as a conductor to interconnect electrodes that are part of the grounding electrode system, or as a grounding electrode conductor. Hold-down bolts securing the structural steel column that are connected to a concrete-encased electrode complying with 250.52(A)(3) and located in the support footing or foundation shall be permitted to connect the metal structural frame of a building or structure to the concrete-encased grounding electrode. The hold-down bolts shall be connected to the concrete-encased electrode by welding, exothermic welding, steel tie wires, or other approved means.
- (3) A rebar-type concrete-encased electrode installed in accordance with 250.52(A)(3) with an additional rebar section extended from its location within the concrete foundation or footing to an accessible location that is not subject to corrosion shall be permitted for connection of

grounding electrode conductors and bonding jumpers in accordance with the following:

- The additional rebar section shall be continuous with the grounding electrode rebar or shall be connected to the grounding electrode rebar and connected together by steel tie wires, exothermic welding, welding, or other effective means.
- The rebar extension shall not be exposed to contact with the earth without corrosion protection.
- Rebar shall not be used as a conductor to interconnect the electrodes of grounding electrode systems.

Δ 250.70 Methods of Grounding and Bonding Conductor Connection to Electrodes.

N (A) General. The grounding or bonding conductor shall be connected to the grounding electrode by exothermic welding, listed lugs, listed pressure connectors, listed clamps, or other listed means. Connections depending on solder shall not be used. Ground clamps shall be listed for the materials of the grounding electrode and the grounding electrode conductor and, if used on pipe, rod, or other buried electrodes, shall also be listed for direct soil burial or concrete encasement. Not more than one conductor shall be connected to the grounding electrode by a single clamp or fitting unless the clamp or fitting is listed for multiple conductors.

N (B) Indoor Communications Systems. For indoor communications purposes only, a listed sheet metal strap-type ground clamp having a rigid metal base that seats on the electrode and having a strap of such material and dimensions that it is not likely to stretch during or after installation shall be permitted.

Informational Note: Listed ground clamps that are identified for direct burial are also suitable for concrete encasement.

Part IV. Enclosure, Raceway, and Service Cable Connections

Δ 250.80 Service Raceways and Enclosures. Metal enclosures and raceways for service conductors and equipment shall be connected to the grounded conductor if the electrical system is grounded or to the grounding electrode conductor for electrical systems that are not grounded.

Exception: Metal components that are installed in a run of underground nonmetallic raceway(s) and are isolated from possible contact by a minimum cover of 450 mm (18 in.) to all parts of the metal components shall not be required to be connected to the grounded conductor, supply-side bonding jumper, or grounding electrode conductor.

250.84 Underground Service Cable or Raceway.

Δ (A) Underground Service Cable. The sheath or armor of a continuous underground metal-sheathed or armored service cable system that is connected to the grounded conductor on the supply side shall not be required to be connected to the grounded conductor at the building or structure. The sheath or armor shall be permitted to be insulated from the interior metal raceway or piping.

Δ (B) Underground Service Raceway Containing Cable. An underground metal service raceway that contains a metal-sheathed or armored cable connected to the grounded conductor shall not be required to be connected to the grounded conductor at the building or structure. The sheath or armor shall be permitted to be insulated from the interior metal raceway or piping.

250.86 Other Conductor Enclosures and Raceways. Except as permitted by 250.112(I), metal enclosures and raceways for other than service conductors shall be connected to the equipment grounding conductor.

Exception No. 1: Metal enclosures and raceways for conductors added to existing installations of open wire, knob-and-tube wiring, and nonmetallic-sheathed cable shall not be required to be connected to the equipment grounding conductor if these enclosures or wiring methods comply with all the following:

- Do not provide an equipment ground*
- Are in runs of less than 7.5 m (25 ft)*
- Are free from probable contact with ground, grounded metal, metal lath, or other conductive material*
- Are guarded against contact by persons*

Exception No. 2: Short sections of metal enclosures or raceways used to provide support or protection of cable assemblies from physical damage shall not be required to be connected to the equipment grounding conductor.

Exception No. 3: Metal components shall not be required to be connected to the equipment grounding conductor or supply-side bonding jumper if either of the following conditions exist:

- The metal components are installed in a run of nonmetallic raceway(s) and isolated from possible contact by a minimum cover of 450 mm (18 in.) to any part of the metal components.*
- The metal components are part of an installation of nonmetallic raceway(s) and are isolated from possible contact to any part of the metal components by being encased in not less than 50 mm (2 in.) of concrete.*

Part V. Bonding

250.90 General. Bonding shall be provided if necessary to ensure electrical continuity and the capacity to conduct safely any fault current likely to be imposed.

250.92 Services.

(A) Bonding of Equipment for Services. The normally non-current-carrying metal parts of equipment indicated in the following shall be bonded together:

- All raceways, cable trays, cablebus framework, auxiliary gutters, or service cable armor or sheath that enclose, contain, or support service conductors, except as permitted in 250.80
- All enclosures containing service conductors, including meter fittings, boxes, or the like, interposed in the service raceway or armor

Δ (B) Method of Bonding at the Service. Bonding jumpers meeting the requirements of this article shall be used around impaired connections, such as reducing washers or oversized, concentric, or eccentric knockouts. Standard locknuts or bushings shall not be the only means for the bonding required by this section but shall be permitted to be installed to make a mechanical connection of the raceway(s).

Electrical continuity at service equipment, service raceways, and service conductor enclosures shall be ensured by one or more of the following methods:

- Bonding equipment to the grounded service conductor by an applicable method in 250.8(A)

- (2) Connections made up wrenchtight using threaded couplings, threaded entries, or listed threaded hubs on enclosures
- (3) Threadless couplings and connectors if made up tight for metal raceways and metal-clad cables
- (4) Other listed devices, such as bonding-type locknuts, bushings, or bushings with bonding jumpers

250.94 Bonding for Communications Systems. Communications system bonding conductor terminations shall be connected in accordance with 250.94(A) or (B).

Δ (A) The Intersystem Bonding Termination Device. An intersystem bonding termination (IBT) for connecting intersystem bonding conductors shall be provided external to enclosures at the service equipment or metering equipment enclosure and at the disconnecting means for any buildings or structures that are supplied by a feeder or branch circuit. If an IBT is used, it shall comply with the following:

- (1) Be accessible for connection and inspection
- (2) Consist of a set of terminals with the capacity for connection of not less than three intersystem bonding conductors
- (3) Not interfere with opening the enclosure for a service, building or structure disconnecting means, or metering equipment
- (4) Be securely mounted as follows:
 - a. At the service equipment, to a metal enclosure for the service equipment, to a metal meter enclosure, or to an exposed nonflexible metal service raceway, or be connected to the metal enclosure for the grounding electrode conductor with a minimum 6 AWG copper conductor
 - b. At the disconnecting means for a building or structure that is supplied by a feeder or branch circuit, be electrically connected to the metal enclosure for the building or structure disconnecting means, or be connected to the metal enclosure for the grounding electrode conductor with a minimum 6 AWG copper conductor
- (5) Be listed as grounding and bonding equipment

Exception: In existing buildings or structures, if any of the intersystem bonding and grounding electrode conductors required by 770.100(B)(2), 800.100(B)(2), 810.21(F)(2), and 820.100 exist, installation of an IBT shall not be required. An accessible means external to enclosures for connecting intersystem bonding and grounding electrode conductors shall be permitted at the service equipment and at the disconnecting means for any buildings or structures that are supplied by a feeder or branch circuit by at least one of the following means:

- (1) Exposed nonflexible metal raceways
- (2) An exposed grounding electrode conductor
- (3) Approved means for the external connection of a copper or other corrosion-resistant bonding or grounding electrode conductor to the grounded raceway or equipment

Informational Note: See 770.100, 800.100, 810.21, and 820.100 for intersystem bonding and grounding requirements for conductive optical fiber cables, communications circuits, radio and television equipment, CATV circuits, and network-powered broadband communications systems, respectively.

(B) Other Means. Connections to an aluminum or copper busbar not less than 6 mm thick × 50 mm wide (¼ in. thick × 2 in. wide) and of a length to accommodate at least three terminations for communication systems in addition to other

connections. The busbar shall be securely fastened and shall be installed in an accessible location. Connections shall be made by a listed connector. If aluminum busbars are used, the installation shall also comply with 250.64(A). The busbar shall be connected to the grounding electrode system by a conductor that is the larger of the following:

- (1) The largest grounding electrode conductor that is connected to the busbar
- (2) As required or permitted in 250.94(A)

Exception to (A) and (B): Means for connecting intersystem bonding conductors are not required if communications systems are not likely to be used in or on the building or structure.

Informational Note: The use of an IBT can reduce electrical noise on communication systems.

250.96 Bonding Other Enclosures.

Δ (A) General. Metal raceways, cable trays, cable armor, cable sheath, enclosures, frames, fittings, and other metal non-current-carrying parts that are to serve as equipment grounding conductors, with or without the use of wire-type supplementary equipment grounding conductors, shall be bonded if necessary to ensure electrical continuity and the capacity to conduct fault current likely to be imposed on them. Any nonconductive paint, enamel, or similar coating shall be removed at threads, contact points, and contact surfaces or shall be connected by means of fittings designed so as to make such removal unnecessary.

(B) Isolated Grounding Circuits. If installed for the reduction of electromagnetic interference on the grounding circuit, an equipment enclosure supplied by a branch circuit shall be permitted to be isolated from a raceway containing circuits supplying only that equipment by one or more listed nonmetallic raceway fittings located at the point of attachment of the raceway to the equipment enclosure. The metal raceway shall comply with this article and shall be supplemented by an internal insulated equipment grounding conductor installed in accordance with 250.146(D) to ground the equipment enclosure.

Informational Note: Use of an isolated equipment grounding conductor does not relieve the requirement for grounding the raceway system.

250.97 Bonding for Over 250 Volts to Ground. For circuits of over 250 volts to ground, the electrical continuity of metal raceways and cables with metal sheaths that contain any conductor other than service conductors shall be ensured by one or more of the methods specified for services in 250.92(B), except for (B)(1).

Exception: If oversized, concentric, or eccentric knockouts are not encountered, or if a box or enclosure with concentric or eccentric knockouts is listed to provide a reliable bonding connection, the following methods shall be permitted:

- (1) Threadless couplings and connectors for cables with metal sheaths
- (2) Two locknuts, on rigid metal conduit or intermediate metal conduit, one inside and one outside of boxes and cabinets
- (3) Fittings with shoulders that seat tightly against the box or cabinet, such as electrical metallic tubing connectors, flexible metal conduit connectors, and cable connectors, with one locknut on the inside of boxes and cabinets
- (4) Listed fittings

250.98 Bonding Loosely Jointed Metal Raceways. Expansion, expansion-deflection, or deflection fittings and telescoping sections of metal raceways shall be made electrically continuous by equipment bonding jumpers or other means.

250.100 Bonding in Hazardous (Classified) Locations. Regardless of the voltage of the electrical system, the electrical continuity of normally non-current-carrying metal parts of electrical equipment, raceways, metal-clad cable, and metal enclosures containing electrical equipment in any hazardous (classified) location, as defined in 500.5, 505.5, and 506.5, shall be ensured by any of the bonding methods specified in 250.92(B)(2) through (B)(4). One or more of these bonding methods shall be used whether or not equipment grounding conductors of the wire type are installed in the raceway or in a multiconductor cable assembly.

Informational Note: See 501.30, 502.30, 503.30, 505.30, or 506.30 for specific bonding requirements.

250.102 Grounded Conductor, Bonding Conductors, and Jumpers.

(A) Material. Bonding jumpers shall be of copper, aluminum, copper-clad aluminum, or other corrosion-resistant material. A bonding jumper shall be a wire, bus, screw, or similar suitable conductor.

(B) Attachment. Bonding jumpers shall be attached in the manner specified in 250.8 for circuits and equipment and in 250.70 for grounding electrodes.

(C) Size — Supply-Side Bonding Jumper.

(1) Size for Supply Conductors in a Single Raceway or Cable. The supply-side bonding jumper shall not be smaller than specified in Table 250.102(C)(1).

Δ (2) Size for Parallel Conductor Installations in Two or More Raceways or Cables. If the ungrounded supply conductors are connected in parallel in two or more raceways or cables, the supply-side bonding jumper shall be sized in accordance with either of the following:

- (1) An individual bonding jumper for each raceway or cable shall be selected from Table 250.102(C)(1) based on the size of the largest ungrounded supply conductor in each raceway or cable.
- (2) A single bonding jumper installed for bonding two or more raceways or cables shall be sized in accordance with Table 250.102(C)(1) based on the sum of the circular mil areas of the largest ungrounded conductors from each set connected in parallel in each raceway or cable. The size of the grounded conductor(s) in each raceway or cable shall be based on the largest ungrounded conductor in each raceway or cable, or the sum of the circular mil areas of the largest ungrounded conductors from each set connected in parallel in each raceway or cable.

Informational Note No. 1: The term *supply conductors* includes ungrounded conductors that do not have overcurrent protection on their supply side and terminate at service equipment or the first disconnecting means of a separately derived system.

Informational Note No. 2: See Chapter 9, Table 8, for the circular mil area of conductors 18 AWG through 4/0 AWG.

(D) Size — Equipment Bonding Jumper on Load Side of an Overcurrent Device. The equipment bonding jumper on the

Δ Table 250.102(C)(1) Grounded Conductor, Main Bonding Jumper, System Bonding Jumper, and Supply-Side Bonding Jumper for Alternating-Current Systems

Size of Largest Ungrounded Conductor or Equivalent Area for Parallel Conductors (AWG/kcmil)		Size of Grounded Conductor or Bonding Jumper (AWG/kcmil)	
Copper	Aluminum or Copper-Clad Aluminum	Copper	Aluminum or Copper-Clad Aluminum
2 or smaller	1/0 or smaller	8	6
1 or 1/0	2/0 or 3/0	6	4
2/0 or 3/0	4/0 or 250	4	2
Over 3/0 through 350	Over 250 through 500	2	1/0
Over 350 through 600	Over 500 through 900	1/0	3/0
Over 600 through 1100	Over 900 through 1750	2/0	4/0
Over 1100	Over 1750	See Notes 1 and 2.	

Notes:

1. If the circular mil area of ungrounded supply conductors that are connected in parallel is larger than 1100 kcmil copper or 1750 kcmil aluminum, the grounded conductor or bonding jumper shall have an area not less than 12½ percent of the area of the largest ungrounded supply conductor or equivalent area for parallel supply conductors. The grounded conductor or bonding jumper shall not be required to be larger than the largest ungrounded conductor or set of ungrounded conductors.
2. If the circular mil area of ungrounded supply conductors that are connected in parallel is larger than 1100 kcmil copper or 1750 kcmil aluminum and if the ungrounded supply conductors and the bonding jumper are of different materials (copper, aluminum, or copper-clad aluminum), the minimum size of the grounded conductor or bonding jumper shall be based on the assumed use of ungrounded supply conductors of the same material as the grounded conductor or bonding jumper that has an ampacity equivalent to that of the installed ungrounded supply conductors.
3. If there are no service-entrance conductors, the supply conductor size shall be determined by the equivalent size of the largest service-entrance conductor required for the load to be served.

load side of an overcurrent device(s) shall be sized in accordance with 250.122.

A single common continuous equipment bonding jumper shall be permitted to connect two or more raceways or cables if the bonding jumper is sized in accordance with 250.122 for the largest overcurrent device supplying circuits therein.

(E) Installation. Bonding jumpers or conductors and equipment bonding jumpers shall be permitted to be installed inside or outside of a raceway or an enclosure.

(1) Inside a Raceway or an Enclosure. If installed inside a raceway, equipment bonding jumpers and bonding jumpers or conductors shall comply with the requirements of 250.119 and 250.148.

(2) Outside a Raceway or an Enclosure. If installed on the outside, the length of the bonding jumper or conductor or equipment bonding jumper shall not exceed 1.8 m (6 ft) and shall be routed with the raceway or enclosure.

Exception: An equipment bonding jumper or supply-side bonding jumper longer than 1.8 m (6 ft) shall be permitted at outside pole locations for the purpose of bonding or grounding isolated sections of metal raceways or elbows installed in exposed risers of metal conduit or other metal raceway, and for bonding grounding electrodes, and shall not be required to be routed with a raceway or enclosure.

(3) Protection. Bonding jumpers or conductors and equipment bonding jumpers shall be installed in accordance with 250.64(A) and (B).

250.104 Bonding of Piping Systems and Exposed Structural Metal.

(A) Metal Water Piping. The metal water piping system shall be bonded as required in 250.104(A) (1), (A) (2), or (A) (3).

(1) General. Metal water piping system(s) installed in or attached to a building or structure shall be bonded to any of the following:

- (1) Service equipment enclosure
- (2) Grounded conductor at the service
- (3) Grounding electrode conductor, if of sufficient size
- (4) One or more grounding electrodes used, if the grounding electrode conductor or bonding jumper to the grounding electrode is of sufficient size

The bonding jumper(s) shall be installed in accordance with 250.64(A), (B), and (E). The points of attachment of the bonding jumper(s) shall be accessible. The bonding jumper(s) shall be sized in accordance with Table 250.102(C) (1) except that it shall not be required to be larger than 3/0 copper or 250 kcmil aluminum or copper-clad aluminum and except as permitted in 250.104(A) (2) and (A) (3).

(2) Buildings of Multiple Occupancy. In buildings of multiple occupancy where the metal water piping system(s) installed in or attached to a building or structure for the individual occupancies is metallically isolated from all other occupancies by use of nonmetallic water piping, the metal water piping system(s) for each occupancy shall be permitted to be bonded to the equipment grounding terminal of the switchgear, switchboard, or panelboard enclosure (other than service equipment) supplying that occupancy. The bonding jumper shall be sized in accordance with 250.102(D).

(3) Buildings or Structures Supplied by a Feeder(s) or Branch Circuit(s). The metal water piping system(s) installed in or attached to a building or structure shall be bonded to any of the following:

- (1) Building or structure disconnecting means enclosure where located at the building or structure
- (2) Equipment grounding conductor run with the supply conductors
- (3) One or more grounding electrodes used

The bonding jumper(s) shall be sized in accordance with 250.102(D). The bonding jumper shall not be required to be larger than the largest ungrounded feeder or branch-circuit conductor supplying the building or structure.

Δ (B) Other Metal Piping. If installed in or attached to a building or structure, a metal piping system(s), including gas piping,

that is likely to become energized shall be bonded to any of the following:

- (1) Equipment grounding conductor for the circuit that is likely to energize the piping system
- (2) Service equipment enclosure
- (3) Grounded conductor at the service
- (4) Grounding electrode conductor, if of sufficient size
- (5) One or more grounding electrodes used, if the grounding electrode conductor or bonding jumper to the grounding electrode is of sufficient size

The bonding conductor(s) or jumper(s) shall be sized in accordance with Table 250.122, and equipment grounding conductors shall be sized in accordance with Table 250.122 using the rating of the circuit that is likely to energize the piping system(s). The points of attachment of the bonding jumper(s) shall be accessible.

Informational Note No. 1: Bonding all piping and metal air ducts within the premises will provide additional safety.

Informational Note No. 2: See NFPA 54, *National Fuel Gas Code*, and NFPA 780, *Standard for the Installation of Lightning Protection Systems*, for information on gas piping systems.

(C) Structural Metal. Exposed structural metal that is interconnected to form a metal building frame, is not intentionally grounded or bonded, and is likely to become energized shall be bonded to any of the following:

- (1) Service equipment enclosure
- (2) Grounded conductor at the service
- (3) Disconnecting means for buildings or structures supplied by a feeder or branch circuit
- (4) Grounding electrode conductor, if not smaller than a conductor sized in accordance with Table 250.102(C) (1)
- (5) One or more grounding electrodes used, if the grounding electrode conductor or bonding jumper to the grounding electrode is not smaller than a conductor sized in accordance with Table 250.102(C) (1)

The bonding conductor(s) or jumper(s) shall be sized in accordance with Table 250.102(C) (1), except that it shall not be required to be larger than 3/0 AWG copper or 250 kcmil aluminum or copper-clad aluminum, and installed in accordance with 250.64(A), (B), and (E). The points of attachment of the bonding jumper(s) shall be accessible unless installed in compliance with 250.68(A), Exception No. 2.

(D) Separately Derived Systems. Metal water piping systems and structural metal that is interconnected to form a building frame shall be bonded to separately derived systems in accordance with 250.104(D) (1) through (D) (3).

(1) Metal Water Piping System(s). The grounded conductor of each separately derived system shall be bonded to the nearest accessible point of the metal water piping system(s) in the area served by each separately derived system. This connection shall be made at the same point on the separately derived system where the grounding electrode conductor is connected. Each bonding jumper shall be sized in accordance with Table 250.102(C) (1) based on the largest ungrounded conductor of the separately derived system except that it shall not be required to be larger than 3/0 AWG copper or 250 kcmil aluminum or copper-clad aluminum.

Exception No. 1: A separate bonding jumper to the metal water piping system shall not be required if the metal water piping system is used as the grounding electrode or grounding electrode conductor for the sepa-

rately derived system and the connection to the water piping system is in the area served by the separately derived system.

Exception No. 2: A separate bonding jumper to the metal water piping system shall not be required if the metal in-ground support structure is used as a grounding electrode or the metal frame of a building or structure is used as the grounding electrode conductor for a separately derived system and is bonded to the metal water piping system in the area served by the separately derived system.

(2) Structural Metal. If exposed structural metal that is interconnected to form the building frame exists in the area served by the separately derived system, it shall be bonded to the grounded conductor of each separately derived system. This connection shall be made at the same point on the separately derived system where the grounding electrode conductor is connected. Each bonding jumper shall be sized in accordance with Table 250.102(C)(1) based on the largest ungrounded conductor of the separately derived system except that it shall not be required to be larger than 3/0 AWG copper or 250 kcmil aluminum or copper-clad aluminum.

Exception No. 1: A separate bonding jumper to the building structural metal shall not be required if the metal in-ground support structure is used as a grounding electrode or the metal frame of a building or structure is used as the grounding electrode conductor for the separately derived system.

Exception No. 2: A separate bonding jumper to the building structural metal shall not be required if the water piping system of a building or structure is used as the grounding electrode or grounding electrode conductor for a separately derived system and is bonded to the building structural metal in the area served by the separately derived system.

(3) Common Grounding Electrode Conductor. If a common grounding electrode conductor is installed for multiple separately derived systems as permitted by 250.30(A)(6), and exposed structural metal that is interconnected to form the building frame or interior metal water piping exists in the area served by the separately derived system, the metal water piping and the structural metal member shall be bonded to the common grounding electrode conductor in the area served by the separately derived system.

Exception: A separate bonding jumper from each derived system to metal water piping and to structural metal members shall not be required if the metal water piping and the structural metal members in the area served by the separately derived system are bonded to the common grounding electrode conductor.

Δ 250.106 Lightning Protection Systems. The lightning protection system ground terminals shall be bonded to the building or structure grounding electrode system.

Informational Note No. 1: See 250.60 for use of strike termination devices.

Informational Note No. 2: See NFPA 780, *Standard for the Installation of Lightning Protection Systems*, which contains detailed information on grounding, bonding, and sideflash distance from lightning protection systems.

Part VI. Equipment Grounding and Equipment Grounding Conductors

250.109 Metal Enclosures. Metal enclosures shall be permitted to be used to connect bonding jumpers or equipment grounding conductors, or both, together to become a part of an effective

ground-fault current path. If installed, metal covers, plaster rings, extension rings, and metal fittings shall be attached to these metal enclosures to ensure an effective ground-fault current path or shall be connected with bonding jumpers or equipment grounding conductors, or both.

Informational Note: See 250.97 for bonding requirements for over 250 volts to ground.

Δ 250.110 Equipment Fastened in Place (Fixed) or Connected by Permanent Wiring Methods. Exposed, normally non-current-carrying metal parts of fixed equipment supplied by or enclosing conductors or components that are likely to become energized shall be connected to an equipment grounding conductor under any of the following conditions:

- (1) If within 2.5 m (8 ft) vertically or 1.5 m (5 ft) horizontally of ground or grounded metal objects and subject to contact by persons
- (2) If located in a wet or damp location and not isolated
- (3) If in electrical contact with metal
- (4) If in a hazardous (classified) location
- (5) If supplied by a wiring method that provides an equipment grounding conductor, except as permitted by 250.86, Exception No. 2, for short sections of metal enclosures
- (6) If equipment operates with any terminal at over 150 volts to ground

Exception No. 1: If exempted by special permission, the metal frame of electrically heated appliances that have the frame permanently and effectively insulated from ground shall not be required to be grounded.

Exception No. 2: Distribution apparatus, such as transformer and capacitor cases, mounted on wooden poles at a height exceeding 2.5 m (8 ft) above ground or grade level shall not be required to be grounded.

Exception No. 3: Listed equipment protected by a system of double insulation, or its equivalent, shall not be required to be connected to the equipment grounding conductor. If such a system is employed, the equipment shall be distinctively marked.

250.112 Specific Equipment Fastened in Place (Fixed) or Connected by Permanent Wiring Methods. Except as permitted in 250.112(F) and (I), exposed, normally non-current-carrying metal parts of equipment described in 250.112(A) through (K), and normally non-current-carrying metal parts of equipment and enclosures described in 250.112(L) and (M), shall be connected to an equipment grounding conductor, regardless of voltage.

(A) Switchgear and Switchboard Frames and Structures. Switchgear or switchboard frames and structures supporting switching equipment, except frames of 2-wire dc switchgear or switchboards if effectively insulated from ground.

(B) Pipe Organs. Generator and motor frames in an electrically operated pipe organ, unless effectively insulated from ground and the motor driving it.

(C) Motor Frames. Motor frames, as provided by 430.242.

(D) Enclosures for Motor Controllers. Enclosures for motor controllers unless attached to ungrounded portable equipment.

(E) Elevators and Cranes. Electrical equipment for elevators and cranes.

(F) Garages, Theaters, and Motion Picture Studios. Electrical equipment in commercial garages, theaters, and motion picture studios, except pendant lampholders supplied by circuits not over 150 volts to ground.

(G) Electric Signs. Electric signs, outline lighting, and associated equipment as provided in 600.7.

(H) Motion Picture Projection Equipment. Motion picture projection equipment.

(I) Remote-Control, Signaling, and Fire Alarm Circuits. Equipment supplied by Class 1 circuits shall be grounded unless operating at less than 50 volts. Equipment supplied by Class 1 power-limited circuits, by Class 2 and Class 3 remote-control and signaling circuits, and by fire alarm circuits shall be grounded if system grounding is required by Part II or Part VIII of this article.

(J) Luminaires. Luminaires as provided in Part V of Article 410.

(K) Skid-Mounted Equipment. Permanently mounted electrical equipment and skids shall be connected to the equipment grounding conductor. Wire-type equipment grounding conductors shall be sized as required by 250.122.

(L) Motor-Operated Water Pumps. Motor-operated water pumps, including the submersible type.

(M) Metal Well Casings. If a submersible pump is used in a metal well casing, the well casing shall be connected to the pump circuit equipment grounding conductor.

Δ 250.114 Equipment Connected by Cord and Plug. Exposed, normally non-current-carrying metal parts of cord-and-plug-connected equipment shall be connected to the equipment grounding conductor under any of the following conditions:

Exception: Listed tools, listed appliances, and listed equipment covered in 250.114, list items 2 through 4, shall not be required to be connected to an equipment grounding conductor if protected by a system of double insulation or its equivalent. Double-insulated equipment shall be distinctively marked.

- (1) In hazardous (classified) locations
- (2) If operated at over 150 volts to ground

Exception No. 1 to (2): Motors, if guarded, shall not be required to be connected to an equipment grounding conductor.

Exception No. 2 to (2): Metal frames of electrically heated appliances, exempted by special permission, shall not be required to be connected to an equipment grounding conductor, in which case the frames shall be permanently and effectively insulated from ground.

- (3) In residential occupancies:
 - a. Refrigerators, freezers, icemakers, and air conditioners
 - b. Clothes-washing, clothes-drying, and dish-washing machines; ranges; kitchen waste disposers; information technology equipment; sump pumps; and electrical aquarium equipment
 - c. Hand-held motor-operated tools, stationary and fixed motor-operated tools, and light industrial motor-operated tools
 - d. Motor-operated appliances of the following types: hedge clippers, lawn mowers, snow blowers, and wet scrubbers
 - e. Portable handlamps

- (4) In other than residential occupancies:
 - a. Refrigerators, freezers, icemakers, and air conditioners
 - b. Clothes-washing, clothes-drying, and dish-washing machines; information technology equipment; sump pumps; and electrical aquarium equipment
 - c. Hand-held motor-operated tools, stationary and fixed motor-operated tools, and light industrial motor-operated tools
 - d. Motor-operated appliances of the following types: hedge clippers, lawn mowers, snow blowers, and wet scrubbers
 - e. Portable handlamps
 - f. Cord-and-plug-connected appliances used in damp or wet locations or by persons standing on the ground, standing on metal floors, or working inside of metal tanks or boilers
 - g. Tools likely to be used in wet or conductive locations

Exception: Tools and portable handlamps and portable luminaires likely to be used in wet or conductive locations shall not be required to be connected to an equipment grounding conductor if supplied through an isolating transformer with an ungrounded secondary of not over 50 volts.

250.116 Nonelectrical Equipment. The metal parts of the following nonelectrical equipment described in this section shall be connected to the equipment grounding conductor:

- (1) Frames and tracks of electrically operated cranes and hoists
- (2) Frames of nonelectrically driven elevator cars to which electrical conductors are attached
- (3) Hand-operated metal shifting ropes or cables of electric elevators

Informational Note: If extensive metal in or on buildings or structures may become energized and is subject to personal contact, adequate bonding and grounding will provide additional safety.

Δ 250.118 Types of Equipment Grounding Conductors.

Δ (A) Permitted. Each equipment grounding conductor run with or enclosing the circuit conductors shall be one or more or a combination of the following:

- (1) A copper, aluminum, or copper-clad aluminum conductor. This conductor shall be solid or stranded; insulated, covered, or bare; and in the form of a wire or a busbar of any shape.
- (2) Rigid metal conduit.
- (3) Intermediate metal conduit.
- (4) Electrical metallic tubing.
- (5) Listed flexible metal conduit meeting all the following conditions:
 - a. The conduit is terminated in listed fittings.
 - b. The circuit conductors contained in the conduit are protected by overcurrent devices rated at 20 amperes or less.
 - c. The size of the conduit does not exceed metric designator 35 (trade size 1¼).
 - d. The combined length of flexible metal conduit, flexible metallic tubing, and liquidtight flexible metal conduit in the same effective ground-fault current path does not exceed 1.8 m (6 ft).

- e. If flexibility is necessary to minimize the transmission of vibration from equipment or to provide flexibility for equipment that requires movement after installation, a wire-type equipment grounding conductor or a bonding jumper in accordance with 250.102(E)(2) shall be installed.
 - f. If flexible metal conduit is constructed of stainless steel, a wire-type equipment grounding conductor or bonding jumper in accordance with 250.102(E)(2) shall be installed.
- (6) Listed liquidtight flexible metal conduit meeting all the following conditions:
- a. The conduit is terminated in listed fittings.
 - b. For metric designators 12 through 16 (trade sizes $\frac{3}{8}$ through $\frac{1}{2}$), the circuit conductors contained in the conduit are protected by overcurrent devices rated at 20 amperes or less.
 - c. For metric designators 21 through 35 (trade sizes $\frac{3}{4}$ through $1\frac{1}{4}$), the circuit conductors contained in the conduit are protected by overcurrent devices rated not more than 60 amperes and there is no flexible metal conduit, flexible metallic tubing, or liquidtight flexible metal conduit in metric designators 12 through 16 (trade sizes $\frac{3}{8}$ through $\frac{1}{2}$) in the effective ground-fault current path.
 - d. The combined length of flexible metal conduit, flexible metallic tubing, and liquidtight flexible metal conduit in the same effective ground-fault current path does not exceed 1.8 m (6 ft).
 - e. If flexibility is necessary to minimize the transmission of vibration from equipment or to provide flexibility for equipment that requires movement after installation, a wire-type equipment grounding conductor or a bonding jumper in accordance with 250.102(E)(2) shall be installed.
 - f. If liquidtight flexible metal conduit contains a stainless steel core, a wire-type equipment grounding conductor or a bonding jumper in accordance with 250.102(E)(2) shall be installed.
- (7) Flexible metallic tubing if the tubing is terminated in listed fittings and meeting the following conditions:
- a. The circuit conductors contained in the tubing are protected by overcurrent devices rated at 20 amperes or less.
 - b. The combined length of flexible metal conduit, flexible metallic tubing, and liquidtight flexible metal conduit in the same effective ground-fault current path does not exceed 1.8 m (6 ft).
- (8) Armor of Type AC cable as provided in 320.108.
- (9) The copper sheath of mineral-insulated, metal-sheathed cable Type MI.
- (10) Type MC cable that provides an effective ground-fault current path in accordance with one or more of the following:
- a. It contains an insulated or uninsulated equipment grounding conductor in compliance with 250.118(1).
 - b. The combined metallic sheath and uninsulated equipment grounding/bonding conductor of interlocked metal tape-type MC cable that is listed and identified as an equipment grounding conductor
 - c. The metallic sheath or the combined metallic sheath and equipment grounding conductors of the smooth

- or corrugated tube-type MC cable that is listed and identified as an equipment grounding conductor
- (11) Cable trays as permitted in 392.10 and 392.60.
- (12) Cablebus framework as permitted in 370.60(1).
- (13) Other listed electrically continuous metal raceways and listed auxiliary gutters.
- (14) Surface metal raceways listed for grounding.

Informational Note: See Article 100 for a definition of *effective ground-fault current path*.

(B) Not Permitted. The following shall not be used as equipment grounding conductors.

- (1) Grounding electrode conductors

Exception: A wire-type equipment grounding conductor installed in compliance with 250.6(A) and the applicable requirements for both the equipment grounding conductor and the grounding electrode conductor in Parts II, III, and VI of this article shall be permitted to serve as both an equipment grounding conductor and a grounding electrode conductor.

- (2) Structural metal frame of a building or structure

• **250.119 Identification of Wire-Type Equipment Grounding Conductors.**

(A) General. Unless required elsewhere in this *Code*, equipment grounding conductors shall be permitted to be bare, covered, or insulated. Individually covered or insulated equipment grounding conductors of the wire type shall have a continuous outer finish that is either green or green with one or more yellow stripes except as permitted in this section. Conductors with insulation or individual covering that is green, green with one or more yellow stripes, or otherwise identified as permitted by this section shall not be used for ungrounded or grounded circuit conductors.

Exception No. 1: Power-limited Class 2 or Class 3 cables, power-limited fire alarm cables, or communications cables containing only circuits operating at less than 50 volts ac or 60 volts dc if connected to equipment not required to be grounded shall be permitted to use a conductor with green insulation or green with one or more yellow stripes for other than equipment grounding purposes.

Exception No. 2: Flexible cords having an integral insulation and jacket without an equipment grounding conductor shall be permitted to have a continuous outer finish that is green.

Informational Note: An example of a flexible cord with integral-type insulation is Type SPT-2, 2 conductor.

Exception No. 3: Conductors with green insulation shall be permitted to be used as ungrounded signal conductors where installed between the output terminations of traffic signal control and traffic signal indicating heads. Signaling circuits installed in accordance with this exception shall include an equipment grounding conductor in accordance with 250.118. Wire-type equipment grounding conductors shall be bare or have insulation or covering that is green with one or more yellow stripes.

(B) Conductors 4 AWG and Larger. Equipment grounding conductors 4 AWG and larger shall comply with the following:

- (1) At the time of installation, if the insulation does not comply with 250.119(A), it shall be permanently identified as an equipment grounding conductor at each end and at every point where the conductor is accessible.

Exception: Conductors 4 AWG and larger shall not be required to be marked in conduit bodies that contain no splices or unused hubs.

- (2) Identification shall encircle the conductor and shall be accomplished by one of the following:
- Stripping the insulation or covering from the entire exposed length
 - Coloring the insulation or covering green at the termination
 - Marking the insulation or covering with green tape or green adhesive labels at the termination

(C) Multiconductor Cable. One or more insulated conductors in a multiconductor cable, at the time of installation, shall be permitted to be permanently identified as equipment grounding conductors at each end and at every point where the conductors are accessible by one of the following means:

- Stripping the insulation from the entire exposed length.
- Coloring the exposed insulation green.
- Marking the exposed insulation with green tape or green adhesive labels. Identification shall encircle the conductor.

(D) Flexible Cord. Equipment grounding conductors in flexible cords shall be insulated and shall have a continuous outer finish that is either green or green with one or more yellow stripes.

250.120 Equipment Grounding Conductor Installation. An equipment grounding conductor shall be installed in accordance with 250.120(A), (B), and (C).

(A) Raceway, Cable Trays, Cable Armor, Cablebus, or Cable Sheaths. If it consists of a raceway, cable tray, cable armor, cablebus framework, or cable sheath or if it is a wire within a raceway or cable, it shall be installed in accordance with the applicable provisions in this *Code* using fittings for joints and terminations approved for use with the type of raceway or cable used. All connections, joints, and fittings shall be made tight using suitable tools.

Informational Note: See the UL Guide Information for Electrical Circuit Integrity Systems (FHIT) for equipment grounding conductors installed in a raceway that are part of a listed electrical circuit protective system or a listed fire-resistive cable system.

Δ (B) Aluminum and Copper-Clad Aluminum Conductors. Equipment grounding conductors of bare, covered, or insulated aluminum or copper-clad aluminum shall comply with the following:

- Unless part of an applicable cable wiring method, bare or covered conductors shall not be installed if subject to corrosive conditions or be installed in direct contact with concrete, masonry, or the earth.
- Terminations made within outdoor enclosures that are listed and identified for the environment shall be permitted within 450 mm (18 in.) of the bottom of the enclosure.
- Aluminum or copper-clad aluminum conductors external to buildings or enclosures shall not be terminated within 450 mm (18 in.) of the earth, unless terminated within a listed wire connector system.

Δ (C) Equipment Grounding Conductors Smaller Than 6 AWG. If not routed with circuit conductors as permitted in 250.130(C) and 250.134, Exception No. 2, equipment grounding conductors smaller than 6 AWG shall be protected from

physical damage by an identified raceway or cable armor unless installed within hollow spaces of the framing members of buildings or structures and if not subject to physical damage.

250.122 Size of Equipment Grounding Conductors.

(A) General. Copper, aluminum, or copper-clad aluminum equipment grounding conductors of the wire type shall not be smaller than shown in Table 250.122. The equipment grounding conductor shall not be required to be larger than the circuit conductors supplying the equipment. If a cable tray, a raceway, or a cable armor or sheath is used as the equipment grounding conductor, as provided in 250.118 and 250.134(1), it shall comply with 250.4(A)(5) or (B)(4).

Equipment grounding conductors shall be permitted to be sectioned within a multiconductor cable, provided the combined circular mil area complies with Table 250.122.

Δ (B) Increased in Size. If ungrounded conductors are increased in size for any reason other than as required in 310.15(B) or 310.15(C), wire-type equipment grounding conductors, if installed, shall be increased in size proportionately to the increase in circular mil area of the ungrounded conductors.

Exception: Equipment grounding conductors shall be permitted to be sized by a qualified person to provide an effective ground fault current path in accordance with 250.4(A)(5) or (B)(4)

(C) Multiple Circuits. A single equipment grounding conductor shall be permitted to be installed for multiple circuits that are installed in the same raceway, cable, trench, or cable tray. It shall be sized from Table 250.122 for the largest overcurrent device protecting circuit conductors in the raceway, cable, trench, or cable tray. Equipment grounding conductors installed in cable trays shall meet the minimum requirements of 392.10(B)(1)(c).

(D) Motor Circuits. Equipment grounding conductors for motor circuits shall be sized in accordance with 250.122(D)(1) or (D)(2).

(1) General. The equipment grounding conductor size shall not be smaller than determined by 250.122(A) based on the rating of the branch-circuit short-circuit and ground-fault protective device.

(2) Instantaneous-Trip Circuit Breaker and Motor Short-Circuit Protector. If the overcurrent device is an instantaneous-trip circuit breaker or a motor short-circuit protector, the equipment grounding conductor shall be sized not smaller than that given by 250.122(A) using the maximum permitted rating of a dual element time-delay fuse selected for branch-circuit short-circuit and ground-fault protection in accordance with 430.52(C)(1), Exception No. 1.

(E) Flexible Cord and Fixture Wire. The equipment grounding conductor in a flexible cord with the largest circuit conductor 10 AWG or smaller, and the equipment grounding conductor used with fixture wires of any size in accordance with 240.5, shall not be smaller than 18 AWG copper and shall not be smaller than the circuit conductors. The equipment grounding conductor in a flexible cord with a circuit conductor larger than 10 AWG shall be sized in accordance with Table 250.122.

(F) Conductors in Parallel. For circuits of parallel conductors as permitted in 310.10(G), the equipment grounding conduc-

tor shall be installed in accordance with 250.122(F)(1) or (F)(2).

Δ (1) Conductor Installations in Raceways, Auxiliary Gutters, or Cable Trays.

(a) *Single Raceway or Cable Tray, Auxiliary Gutter, or Cable Tray.* If circuit conductors are connected in parallel in the same raceway, auxiliary gutter, or cable tray, a single wire-type conductor shall be permitted as the equipment grounding conductor. The wire-type equipment grounding conductor shall be sized in accordance with 250.122 based on the overcurrent protective device for the feeder or branch circuit.

(b) *Multiple Raceways.* If conductors are installed in multiple raceways and are connected in parallel, a wire-type equipment grounding conductor, if used, shall be installed in each raceway and shall be connected in parallel. The equipment grounding conductor installed in each raceway shall be sized in accordance with 250.122 based on the rating of the overcurrent protective device for the feeder or branch circuit.

(c) *Wire-Type Equipment Grounding Conductors in Cable Trays.* Wire-type equipment grounding conductors installed in cable trays shall meet the minimum requirements of 392.10(B)(1)(c).

(d) *Metal Raceways, Auxiliary Gutters, or Cable Trays.* Metal raceways or auxiliary gutters in accordance with 250.118 or cable trays complying with 392.60(B) shall be permitted as the equipment grounding conductor.

(2) Multiconductor Cables.

(a) Except as provided in 250.122(F)(2)(c) for raceway or cable tray installations, the equipment grounding conductor in each multiconductor cable shall be sized in accordance with 250.122 based on the overcurrent protective device for the feeder or branch circuit.

(b) If circuit conductors of multiconductor cables are connected in parallel, the equipment grounding conductor(s) in each cable shall be connected in parallel.

(c) If multiconductor cables are paralleled in the same raceway, auxiliary gutter, or cable tray, a single equipment grounding conductor that is sized in accordance with 250.122 shall be permitted in combination with the equipment grounding conductors provided within the multiconductor cables and shall all be connected together.

(d) Equipment grounding conductors installed in cable trays shall meet the minimum requirements of 392.10(B)(1)(c). Cable trays complying with 392.60(B), metal raceways in accordance with 250.118, or auxiliary gutters shall be permitted as the equipment grounding conductor.

(G) Feeder Taps. Equipment grounding conductors installed with feeder taps shall not be smaller than shown in Table 250.122 based on the rating of the overcurrent device ahead of the feeder on the supply side ahead of the tap but shall not be required to be larger than the tap conductors.

250.124 Equipment Grounding Conductor Continuity.

(A) Separable Connections. Separable connections such as those provided in drawout equipment or attachment plugs and mating connectors and receptacles shall provide for first-make, last-break of the equipment grounding conductor. First-make, last-break shall not be required if interlocked equipment, plugs, receptacles, and connectors preclude energization without grounding continuity.

(B) Switches. No automatic cutout or switch shall be placed in the equipment grounding conductor of a premises wiring

Table 250.122 Minimum Size Equipment Grounding Conductors for Grounding Raceway and Equipment

Rating or Setting of Automatic Overcurrent Device in Circuit Ahead of Equipment, Conduit, etc., Not Exceeding (Amperes)	Size (AWG or kcmil)	
	Copper	Aluminum or Copper-Clad Aluminum*
15	14	12
20	12	10
60	10	8
100	8	6
200	6	4
300	4	2
400	3	1
500	2	1/0
600	1	2/0
800	1/0	3/0
1000	2/0	4/0
1200	3/0	250
1600	4/0	350
2000	250	400
2500	350	600
3000	400	600
4000	500	750
5000	700	1250
6000	800	1250

Note: Where necessary to comply with 250.4(A)(5) or (B)(4), the equipment grounding conductor shall be sized larger than given in this table.

*See installation restrictions in 250.120.

system unless the opening of the cutout or switch disconnects all sources of energy.

250.126 Identification of Wiring Device Terminals. The terminal for the connection of the equipment grounding conductor shall be identified by one of the following:

- (1) A green, not readily removable terminal screw with a hexagonal head.
- (2) A green, hexagonal, not readily removable terminal nut.
- (3) A green pressure wire connector. If the terminal for the equipment grounding conductor is not visible, the conductor entrance hole shall be marked with the word *green* or *ground*, the letters *G* or *GR*, a grounding symbol, or otherwise identified by a distinctive green color. If the terminal for the equipment grounding conductor is readily removable, the area adjacent to the terminal shall be similarly marked.

Informational Note: See Informational Note Figure 250.126.



Informational Note Figure 250.126 One Example of a Symbol Used to Identify the Grounding Termination Point for an Equipment Grounding Conductor.

Part VII. Methods of Equipment Grounding Conductor Connections

250.130 Equipment Grounding Conductor Connections.

Equipment grounding conductor connections at the source of separately derived systems shall be made in accordance with 250.30(A)(1). Equipment grounding conductor connections at service equipment shall be made as indicated in 250.130(A) or (B). For replacement of non-grounding-type receptacles with grounding-type receptacles, or snap switches without an equipment grounding terminal with snap switches with an equipment grounding terminal, and for branch-circuit extensions only in existing installations that do not have an equipment grounding conductor in the branch circuit, connections shall be permitted as indicated in 250.130(C).

(A) For Grounded Systems. The connection shall be made by bonding the equipment grounding conductor to the grounded service conductor and the grounding electrode conductor.

(B) For Ungrounded Systems. The connection shall be made by bonding the equipment grounding conductor to the grounding electrode conductor.

(C) Replacement of Nongrounding Receptacle or Snap Switch and Branch Circuit Extensions. The equipment grounding conductor that is connected to a grounding-type receptacle, a snap switch with an equipment grounding terminal, or a branch-circuit extension shall be permitted to be connected to any of the following:

- (1) Any accessible point on the grounding electrode system as described in 250.50
- (2) Any accessible point on the grounding electrode conductor
- (3) The equipment grounding terminal bar within the enclosure where the branch circuit for the receptacle or branch circuit originates
- (4) An equipment grounding conductor that is part of another branch circuit that originates from the enclosure where the branch circuit for the receptacle, snap switch, or branch circuit originates
- (5) For grounded systems, the grounded service conductor within the service equipment enclosure
- (6) For ungrounded systems, the grounding terminal bar within the service equipment enclosure

Informational Note No. 1: See 406.4(D) for the use of a ground-fault circuit-interrupting type of receptacle.

Informational Note No. 2: See 404.9(B) for requirements regarding grounding of snap switches.

250.132 Short Sections of Raceway or Cable Armor. Isolated sections of metal raceway or cable armor, if required to be connected to an equipment grounding conductor, shall be connected in accordance with 250.134.

250.134 Equipment Fastened in Place or Connected by Permanent Wiring Methods (Fixed). Unless connected to the grounded circuit conductor as permitted by 250.32, 250.140, and 250.142, non-current-carrying metal parts of equipment, raceways, and other enclosures, if grounded, shall be connected to an equipment grounding conductor by one of the following methods:

- (1) By connecting to any of the equipment grounding conductors permitted by 250.118(2) through (14)

- (2) By connecting to an equipment grounding conductor of the wire type that is contained within the same raceway, contained within the same cable, or otherwise run with the circuit conductors

Exception No. 1: As provided in 250.130(C), the equipment grounding conductor shall be permitted to be run separately from the circuit conductors.

Exception No. 2: For dc circuits, the equipment grounding conductor shall be permitted to be run separately from the circuit conductors

Informational Note No. 1: See 250.102 and 250.168 for equipment bonding jumper requirements.

Informational Note No. 2: See 400.10 for use of flexible cords and flexible cables for fixed equipment.

250.136 Equipment Secured to a Metal Rack or Structure. If a metal rack or structure is connected to an equipment grounding conductor in accordance with 250.134, it shall be permitted to serve as the equipment grounding conductor for electrical equipment secured to and in electrical contact with the metal rack or structure.

250.138 Cord-and-Plug-Connected Equipment. Non-current-carrying metal parts of cord-and-plug-connected equipment, if required to be connected to an equipment grounding conductor, shall be connected by one of the methods in 250.138(A) or (B).

(A) By Means of an Equipment Grounding Conductor. By means of an equipment grounding conductor run with the power supply conductors in a cable assembly or flexible cord properly terminated in a grounding-type attachment plug with one fixed grounding contact.

Exception: The grounding contacting pole of grounding-type plug-in ground-fault circuit interrupters shall be permitted to be of the movable, self-restoring type on circuits operating at not over 150 volts between any two conductors or over 150 volts between any conductor and ground.

(B) By Means of a Separate Flexible Wire or Strap. By means of a separate flexible wire or strap, insulated or bare, connected to an equipment grounding conductor, and protected as well as practicable against physical damage, if part of equipment.

Δ 250.140 Frames of Ranges and Clothes Dryers. Frames of electric ranges, wall-mounted ovens, counter-mounted cooking units, clothes dryers, and outlet or junction boxes that are part of the circuit shall be connected to the equipment grounding conductor in accordance with 250.140(A) or the grounded conductor in accordance with 250.140(B).

N (A) Equipment Grounding Conductor Connections. The circuit supplying the appliance shall include an equipment grounding conductor. The frame of the appliance shall be connected to the equipment grounding conductor in the manner specified by 250.134 or 250.138.

(B) Grounded Conductor Connections. For existing branch-circuit installations only, if an equipment grounding conductor is not present in the outlet or junction box the frame of the appliance shall be permitted to be connected to the grounded conductor if all the conditions in the following list items (1), (2), and (3) are met and the grounded conductor complies with either list item (4) or (5):

- (1) The supply circuit is 120/240-volt, single-phase, 3-wire; or 208Y/120-volt derived from a 3-phase, 4-wire, wye-connected system.
- (2) The grounded conductor is not smaller than 10 AWG copper or 8 AWG aluminum or copper-clad aluminum.
- (3) Grounding contacts of receptacles furnished as part of the equipment are bonded to the equipment.
- (4) The grounded conductor is insulated, or the grounded conductor is uninsulated and part of a Type SE service-entrance cable and the branch circuit originates at the service equipment.
- (5) The grounded conductor is part of a Type SE service-entrance cable that originates in equipment other than a service. The grounded conductor shall be insulated or field covered within the supply enclosure with listed insulating material, such as tape or sleeving to prevent contact of the uninsulated conductor with any normally non-current-carrying metal parts.

250.142 Use of Grounded Circuit Conductor for Grounding Equipment.

(A) Supply-Side Equipment. A grounded circuit conductor shall be permitted to be connected to non-current-carrying metal parts of equipment, raceways, and other enclosures at any of the following locations:

- (1) On the supply side or within the enclosure of the ac service disconnecting means
- (2) On the supply side or within the enclosure of the main disconnecting means for separate buildings as provided in 250.32(B)(1) Exception No. 1
- (3) On the supply side or within the enclosure of the main disconnecting means or overcurrent devices of a separately derived system where permitted by 250.30(A)(1)

(B) Load-Side Equipment. Except as permitted in 250.30(A)(1), 250.32(B)(1), Exception No. 1, and Part X of Article 250, a grounded circuit conductor shall not be connected to non-current-carrying metal parts of equipment on the load side of the service disconnecting means or on the load side of a separately derived system disconnecting means or the overcurrent devices for a separately derived system not having a main disconnecting means.

Exception No. 1: The frames of ranges, wall-mounted ovens, counter-mounted cooking units, and clothes dryers under the conditions permitted for existing installations by 250.140 shall be permitted to be connected to the grounded circuit conductor.

Exception No. 2: It shall be permissible to connect meter enclosures to the grounded circuit conductor on the load side of the service disconnect if all of the following conditions apply:

- (1) Ground-fault protection of equipment is not installed.
- (2) All meter enclosures are located immediately adjacent to the service disconnecting means.
- (3) The size of the grounded circuit conductor is not smaller than the size specified in Table 250.122 for equipment grounding conductors.

Exception No. 3: Electrode-type boilers operating at over 1000 volts shall be grounded as required in 495.72(E)(1) and 495.74.

Δ 250.144 Multiple Circuit Connections. If equipment is required to be grounded and is supplied by more than one circuit containing an equipment grounding conductor, a means to terminate each equipment grounding conductor meeting the requirements of 250.8 shall be provided as specified in 250.134 and 250.138.

250.146 Connecting Receptacle Grounding Terminal to an Equipment Grounding Conductor. An equipment bonding jumper shall be used to connect the grounding terminal of a grounding-type receptacle to a metal box that is connected to an equipment grounding conductor, except as permitted in 250.146(A) through (D). The equipment bonding jumper shall be sized in accordance with Table 250.122.

Δ (A) Surface-Mounted Box. If a metal box is mounted on the surface, the direct metal-to-metal contact between the device yoke or strap to the box shall be permitted to provide the required effective ground-fault current path. At least one of the insulating washers shall be removed from receptacles that do not have a contact yoke or device to ensure direct metal-to-metal contact. Direct metal-to-metal contact for providing continuity applies to cover-mounted receptacles if the box and cover combination are listed as providing continuity between the box and the receptacle. A listed exposed work cover shall be permitted to be the grounding and bonding means under both of the following conditions:

- (1) The device is attached to the cover with at least two fasteners that are permanent (such as a rivet) or have a thread-locking or screw- or nut-locking means.
- (2) The cover mounting holes are located on a flat nonraised portion of the cover.

(B) Contact Devices or Yokes. Contact devices or yokes designed and listed as self-grounding shall be permitted in conjunction with the supporting screws to establish equipment bonding between the device yoke and flush-type boxes.

Δ (C) Floor Boxes. Floor boxes designed for and listed as providing continuity between the box and the device shall be permitted.

(D) Isolated Ground Receptacles. If installed for the reduction of electromagnetic interference on the equipment grounding conductor, a receptacle in which the grounding terminal is purposely insulated from the receptacle mounting means shall be permitted. The receptacle grounding terminal shall be connected to an insulated equipment grounding conductor run with the circuit conductors. This equipment grounding conductor shall be permitted to pass through one or more panelboards without a connection to the panelboard grounding terminal bar as permitted in 408.40, Exception, so as to terminate within the same building or structure directly at an equipment grounding conductor terminal of the applicable derived system or service. If installed in accordance with this section, this equipment grounding conductor shall also be permitted to pass through boxes, wireways, or other enclosures without being connected to such enclosures.

Informational Note: Use of an isolated equipment grounding conductor does not relieve the requirement for connecting the raceway system and outlet box to an equipment grounding conductor.

Δ 250.148 Continuity of Equipment Grounding Conductors and Attachment in Boxes. If circuit conductors are spliced within a box or terminated on equipment within or supported by a box, the installation shall comply with 250.148(A) through (D).

Exception: The equipment grounding conductor permitted in 250.146(D) shall not be required to be connected to the other equipment grounding conductors or to the box.

(A) Connections and Splices. All equipment grounding conductors that are spliced or terminated within the box shall be connected together. Connections and splices shall be made in accordance with 110.14(B) and 250.8 except that insulation shall not be required.

(B) Equipment Grounding Conductor Continuity. The arrangement of grounding connections shall be such that the disconnection or the removal of a luminaire, receptacle, or other device fed from the box does not interrupt the electrical continuity of the equipment grounding conductor(s) providing an effective ground-fault current path.

Δ (C) Metal Boxes. A connection used for no other purpose shall be made between the metal box and the equipment grounding conductor(s). The equipment bonding jumper or equipment grounding conductor shall be sized from Table 250.122 based on the largest overcurrent device protecting circuit conductors in the box.

Δ (D) Nonmetallic Boxes. One or more equipment grounding conductors brought into a nonmetallic outlet box shall be arranged to provide a connection to any fitting or device in that box requiring connection to an equipment grounding conductor.

Part VIII. Direct-Current Systems

250.160 General. Direct-current systems shall comply with Part VIII and other sections of Article 250 not specifically intended for ac systems.

250.162 Direct-Current Circuits and Systems to Be Grounded. Direct-current circuits and systems shall be grounded as provided for in 250.162(A) and (B).

(A) Two-Wire, Direct-Current Systems. A 2-wire, dc system supplying premises wiring and operating at greater than 60 volts but not greater than 300 volts shall be grounded.

Exception No. 1: A system equipped with a ground detector and supplying only industrial equipment in limited areas shall not be required to be grounded if installed immediately adjacent to, or integral with, the source of supply.

Exception No. 2: A rectifier-derived dc system supplied from an ac system complying with 250.20 shall not be required to be grounded.

Exception No. 3: Direct-current fire alarm circuits having a maximum current of 0.030 ampere as specified in Article 760, Part III, shall not be required to be grounded.

(B) Three-Wire, Direct-Current Systems. The neutral conductor of all 3-wire, dc systems supplying premises wiring shall be grounded.

250.164 Point of Connection for Direct-Current Systems.

(A) Off-Premises Source. Direct-current systems to be grounded and supplied from an off-premises source shall have the

grounding connection made at one or more supply stations. A grounding connection shall not be made at individual services or at any point on the premises wiring.

Δ (B) On-Premises Source. If the dc system source is located on the premises, a grounding connection shall be made at one of the following:

- (1) The source
- (2) The first system disconnection means or overcurrent device
- (3) By other means that accomplish system protection and that use equipment listed and identified for the use

250.166 Size of the Direct-Current Grounding Electrode Conductor. The size of the grounding electrode conductor for a dc system shall be as specified in 250.166(A) and (B), except as permitted by 250.166(C) through (E). The grounding electrode conductor for a dc system shall meet the sizing requirements in this section but shall not be required to be larger than 3/0 copper or 250 kcmil aluminum or copper-clad aluminum.

(A) Not Smaller Than the Neutral Conductor. If the dc system consists of a 3-wire balancer set or a balancer winding with overcurrent protection as provided in 445.12(D), the grounding electrode conductor shall not be smaller than the neutral conductor and not smaller than 8 AWG copper or 6 AWG aluminum or copper-clad aluminum.

Δ (B) Not Smaller Than the Largest Conductor. If the dc system is other than as in 250.166(A), the grounding electrode conductor shall not be smaller than the largest conductor supplied by the system and not smaller than 8 AWG copper or 6 AWG aluminum or copper-clad aluminum.

(C) Connected to Rod, Pipe, or Plate Electrodes. If connected to rod, pipe, or plate electrodes as in 250.52(A)(5) or (A)(7), that portion of the grounding electrode conductor that is the sole connection to the grounding electrode shall not be required to be larger than 6 AWG copper wire or 4 AWG aluminum or copper-clad aluminum wire.

(D) Connected to a Concrete-Encased Electrode. If connected to a concrete-encased electrode as in 250.52(A)(3), that portion of the grounding electrode conductor that is the sole connection to the grounding electrode shall not be required to be larger than 4 AWG copper wire.

(E) Connected to a Ground Ring. If connected to a ground ring as in 250.52(A)(4), that portion of the grounding electrode conductor that is the sole connection to the grounding electrode shall not be required to be larger than the conductor used for the ground ring.

250.167 Direct-Current Ground-Fault Detection.

(A) Ungrounded Systems. Ground-fault detection systems shall be required for ungrounded systems.

(B) Grounded Systems. Ground-fault detection shall be permitted for grounded systems.

Δ (C) Marking. Direct-current systems shall be legibly marked to indicate the grounding type at the dc source or the first disconnecting means of the system. The marking shall be of sufficient durability to withstand the environment involved.

Informational Note: See NFPA 70E-2018, *Standard for Electrical Safety in the Workplace*, which identifies four dc grounding types in detail.

250.168 Direct-Current System Bonding Jumper. For direct-current systems that are to be grounded, an unspliced bonding jumper shall be used to connect the equipment grounding conductor(s) to the grounded conductor at the source or to the first system disconnecting means where the system is grounded. The size of the bonding jumper shall not be smaller than the system grounding electrode conductor specified in 250.166 and shall comply with 250.28(A), (B), and (C).

250.169 Ungrounded Direct-Current Separately Derived Systems. Except as otherwise permitted in 250.34 for portable and vehicle-mounted generators, an ungrounded dc separately derived system supplied from a stand-alone power source (such as an engine-generator set) shall have a grounding electrode conductor connected to an electrode that complies with Part III of this article to provide for grounding of metal enclosures, raceways, cables, and exposed non-current-carrying metal parts of equipment. The grounding electrode conductor connection shall be to the metal enclosure at any point on the separately derived system from the source to the first system disconnecting means or overcurrent device, or it shall be made at the source of a separately derived system that has no disconnecting means or overcurrent devices.

The size of the grounding electrode conductor shall be in accordance with 250.166.

Part IX. Instruments, Meters, and Relays

250.170 Instrument Transformer Circuits. Secondary circuits of current and potential instrument transformers shall be grounded if the primary windings are connected to circuits of 300 volts or more to ground and, if installed on or in switchgear and on switchboards, shall be grounded irrespective of voltage.

Exception No. 1: Circuits where the primary windings are connected to circuits of 1000 volts or less with no live parts or wiring exposed or accessible to other than qualified persons.

Exception No. 2: Current transformer secondaries connected in a three-phase delta configuration shall not be required to be grounded.

250.172 Instrument Transformer Cases. Cases or frames of instrument transformers shall be connected to the equipment grounding conductor if accessible to other than qualified persons.

Exception: Cases or frames of current transformers, the primaries of which are not over 150 volts to ground and that are used exclusively to supply current to meters.

250.174 Cases of Instruments, Meters, and Relays Operating at 1000 Volts or Less. Instruments, meters, and relays operating with windings or working parts at 1000 volts or less shall be connected to the equipment grounding conductor as specified in 250.174(A), (B), or (C).

(A) Not on Switchgear or Switchboards. Instruments, meters, and relays not located on switchgear or switchboards operating with windings or working parts at 300 volts or more to ground, and accessible to other than qualified persons, shall have the cases and other exposed metal parts connected to the equipment grounding conductor.

(B) On Switchgear or Dead-Front Switchboards. Instruments, meters, and relays (whether operated from current and potential transformers or connected directly in the circuit) on switch-

gear or switchboards having no live parts on the front of the panels shall have the cases connected to the equipment grounding conductor.

(C) On Live-Front Switchboards. Instruments, meters, and relays (whether operated from current and potential transformers or connected directly in the circuit) on switchboards having exposed live parts on the front of panels shall not have their cases connected to the equipment grounding conductor. Mats of insulating rubber or other approved means of floor insulation shall be provided for the operator where the voltage to ground exceeds 150 volts.

250.176 Cases of Instruments, Meters, and Relays — Operating at Over 1000 Volts. If instruments, meters, and relays have current-carrying parts of over 1000 volts to ground, they shall be isolated by elevation or protected by a barrier(s), grounded metal, or insulating covers or guards. Their cases shall not be connected to the equipment grounding conductor.

Exception: Cases of electrostatic ground detectors shall be permitted to be connected to an equipment grounding conductor if the internal ground segments of the instrument are connected to the instrument case and grounded and the ground detector is isolated by elevation.

Δ 250.178 Instrument Equipment Grounding Conductor. The equipment grounding conductor for secondary circuits of instrument transformers and for instrument cases shall not be smaller than 12 AWG copper or 10 AWG aluminum or copper-clad aluminum. Cases of instrument transformers, instruments, meters, and relays that are mounted directly on grounded metal surfaces of enclosures or grounded metal of switchgear or switchboard panels shall not be required to be connected to an additional equipment grounding conductor.

Part X. Grounding of Systems and Circuits of over 1000 Volts

250.180 General. If systems over 1000 volts are grounded, they shall comply with all applicable requirements of 250.1 through 250.178 and with 250.182 through 250.194, which supplement and modify the preceding sections.

250.182 Derived Neutral Systems. A system neutral point derived from a grounding transformer shall be permitted to be used for grounding systems over 1 kV.

250.184 Solidly Grounded Neutral Systems. Solidly grounded neutral systems shall be permitted to be either single point grounded or multigrounded neutral.

(A) Neutral Conductor.

(1) Insulation Level. The minimum insulation level for neutral conductors of solidly grounded systems shall be 600 volts.

Exception No. 1: For multigrounded neutral systems as permitted in 250.184(C), bare copper conductors shall be permitted to be used for the neutral conductor of the following:

- (1) Service-entrance conductors
- (2) Service laterals or underground service conductors
- (3) Direct-buried portions of feeders

Exception No. 2: Bare conductors shall be permitted for the neutral conductor of overhead portions installed outdoors.

Exception No. 3: The grounded neutral conductor shall be permitted to be a bare conductor if isolated from phase conductors and protected from physical damage.

Informational Note: See 225.4 for conductor covering where within 3.0 m (10 ft) of any building or other structure.

(2) Ampacity. The neutral conductor shall have an ampacity that is not less than the load imposed and be not less than 33⅓ percent of the ampacity of the phase conductors.

Exception: In industrial and commercial premises under engineering supervision, it shall be permissible to size the ampacity of the neutral conductor to not less than 20 percent of the ampacity of the phase conductor.

Δ (B) Single-Point Grounded Neutral System. If a single-point grounded neutral system is used, the following shall apply:

- (1) A single-point grounded neutral system shall be permitted to be supplied from one of the following:
 - a. A separately derived system
 - b. A multigrounded neutral system with an equipment grounding conductor connected to the multigrounded neutral conductor at the source of the single-point grounded neutral system
- (2) A grounding electrode shall be provided for the system.
- (3) A grounding electrode conductor shall connect the grounding electrode to the system neutral conductor.
- (4) A bonding jumper shall connect the equipment grounding conductor to the grounding electrode conductor.
- (5) An equipment grounding conductor shall be provided to each building, structure, and equipment enclosure.
- (6) A neutral conductor shall only be required if phase-to-neutral loads are supplied.
- (7) The neutral conductor, if provided, shall be insulated and isolated from earth except at one location.
- (8) An equipment grounding conductor shall be run with the phase conductors and shall comply with all of the following:
 - a. Shall not carry continuous load
 - b. Shall be bare, covered, or insulated
 - c. Shall have ampacity for fault current duty

(C) Multigrounded Neutral Systems. If a multigrounded neutral system is used, the following shall apply:

- (1) The neutral conductor of a solidly grounded neutral system shall be permitted to be grounded at more than one point. Grounding shall be permitted at one or more of the following locations:
 - a. Transformers supplying conductors to a building or other structure
 - b. Underground circuits if the neutral conductor is exposed
 - c. Overhead circuits installed outdoors
- (2) The multigrounded neutral conductor shall be grounded at each transformer and at other additional locations by connection to a grounding electrode.
- (3) At least one grounding electrode shall be installed and connected to the multigrounded neutral conductor every 400 m (1300 ft).
- (4) The maximum distance between any two adjacent electrodes shall not be more than 400 m (1300 ft).
- (5) In a multigrounded shielded cable system, the shielding shall be grounded at each cable joint that is exposed to personnel contact.

Exception: In a multipoint grounded system, a grounding electrode shall not be required to bond the neutral conductor in an uninterrupted conductor exceeding 400 m (1300 ft) if the only purpose for removing the cable jacket is for bonding the neutral conductor to a grounding electrode.

250.186 Grounding Service-Supplied Alternating-Current Systems.

(A) Systems with a Grounded Conductor at the Service Point.

If an ac system is grounded at any point and is provided with a grounded conductor at the service point, a grounded conductor(s) shall be installed and routed with the ungrounded conductors to each service disconnecting means and shall be connected to each disconnecting means grounded conductor(s) terminal or bus. A main bonding jumper shall connect the grounded conductor(s) to each service disconnecting means enclosure. The grounded conductor(s) shall be installed in accordance with 250.186(A)(1) through (A)(4). The size of the solidly grounded circuit conductor(s) shall be the larger of that determined by 250.184 or 250.186(A)(1) or (A)(2).

Exception: If two or more service disconnecting means are located in a single assembly listed for use as service equipment, it shall be permitted to connect the grounded conductor(s) to the assembly common grounded conductor(s) terminal or bus. The assembly shall include a main bonding jumper for connecting the grounded conductor(s) to the assembly enclosure.

(1) Sizing for a Single Raceway or Overhead Conductor. The grounded conductor shall not be smaller than the required grounding electrode conductor specified in Table 250.102(C)(1) but shall not be required to be larger than the largest ungrounded service-entrance conductor(s).

(2) Parallel Conductors in Two or More Raceways or Overhead Conductors. If the ungrounded service-entrance conductors are installed in parallel in two or more raceways or as overhead parallel conductors, the grounded conductors shall also be installed in parallel. The size of the grounded conductor in each raceway or overhead shall be based on the total circular mil area of the parallel ungrounded conductors in the raceway or overhead, as indicated in 250.186(A)(1), but not smaller than 1/0 AWG.

Informational Note: See 310.10(G) for grounded conductors connected in parallel.

(3) Delta-Connected Service. The grounded conductor of a 3-phase, 3-wire delta service shall have an ampacity not less than that of the ungrounded conductors.

Δ (4) Impedance Grounded Systems. Impedance grounded systems shall be installed in accordance with 250.187.

(B) Systems Without a Grounded Conductor at the Service Point.

If an ac system is grounded at any point and is not provided with a grounded conductor at the service point, a supply-side bonding jumper shall be installed and routed with the ungrounded conductors to each service disconnecting means and shall be connected to each disconnecting means equipment grounding conductor terminal or bus. The supply-side bonding jumper shall be installed in accordance with 250.186(B)(1) through (B)(3).

Exception: If two or more service disconnecting means are located in a single assembly listed for use as service equipment, it shall be permitted to connect the supply-side bonding jumper to the assembly common equipment grounding terminal or bus.

(1) **Sizing for a Single Raceway or Overhead Conductor.** The supply-side bonding jumper shall not be smaller than the required grounding electrode conductor specified in Table 250.102(C)(1) but shall not be required to be larger than the largest ungrounded service-entrance conductor(s).

(2) **Parallel Conductors in Two or More Raceways or Overhead Conductors.** If the ungrounded service-entrance conductors are installed in parallel in two or more raceways or overhead conductors, the supply-side bonding jumper shall also be installed in parallel. The size of the supply-side bonding jumper in each raceway or overhead shall be based on the total circular mil area of the parallel ungrounded conductors in the raceway or overhead, as indicated in 250.186(A)(1), but not smaller than 1/0 AWG.

Δ (3) **Impedance Grounded Systems.** Impedance grounded systems shall be installed in accordance with 250.187.

250.187 Impedance Grounded Systems. Impedance grounded systems in which a grounding impedance device, typically a resistor, limits the ground-fault current shall be permitted if all of the following conditions are met:

- (1) The conditions of maintenance and supervision ensure that only qualified persons service the installation.
- (2) Ground detectors are installed on the system.
- (3) Line-to-neutral loads are not served.

Impedance grounded systems shall comply with 250.187(A) through (D).

(A) **Location.** The grounding impedance device shall be installed between the grounding electrode conductor and the impedance grounding conductor connected to the system neutral point.

(B) **Insulated.** The impedance grounding conductor shall be insulated for the maximum neutral voltage.

Exception: A bare impedance grounding conductor shall be permitted if the bare portion of the grounding impedance device and conductor are not in a readily accessible location and securely separated from the ungrounded conductors.

Informational Note: The maximum neutral voltage in a 3-phase wye system is 57.7 percent of the phase-to-phase voltage.

(C) **System Neutral Point Connection.** The system neutral point shall not be connected to ground, except through the grounding impedance device.

(D) **Equipment Grounding Conductors.** Equipment grounding conductors shall be permitted to be bare and shall be electrically connected to the ground bus and grounding electrode conductor.

250.188 Grounding of Systems Supplying Portable or Mobile Equipment. Systems supplying portable or mobile equipment over 1000 volts, other than substations installed on a temporary basis, shall comply with 250.188(A) through (F).

(A) **Portable or Mobile Equipment.** Portable or mobile equipment over 1000 volts shall be supplied from a system having its neutral conductor grounded through an impedance. If a delta-connected system over 1000 volts is used to supply portable or mobile equipment, a system neutral point and associated neutral conductor shall be derived.

(B) **Exposed Non-Current-Carrying Metal Parts.** Exposed non-current-carrying metal parts of portable or mobile equipment

shall be connected by an equipment grounding conductor to the point at which the system neutral impedance is grounded.

(C) **Ground-Fault Current.** The voltage developed between the portable or mobile equipment frame and ground by the flow of maximum ground-fault current shall not exceed 100 volts.

(D) **Ground-Fault Detection and Relaying.** Ground-fault detection and relaying shall be provided to automatically de-energize any component of a system over 1000 volts that has developed a ground fault. The continuity of the equipment grounding conductor shall be continuously monitored so as to automatically de-energize the circuit of the system over 1000 volts to the portable or mobile equipment upon loss of continuity of the equipment grounding conductor.

(E) **Isolation.** The grounding electrode to which the portable or mobile equipment system neutral impedance is connected shall be isolated from and separated in the ground by at least 6.0 m (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 and fence, and so forth.

(F) **Trailing Cable and Couplers.** Trailing cable and couplers of systems over 1000 volts for interconnection of portable or mobile equipment shall meet the requirements of Part III of Article 400 for cables and 495.65 for couplers.

250.190 Grounding of Equipment.

(A) **Equipment Grounding.** All non-current-carrying metal parts of fixed, portable, and mobile equipment and associated fences, housings, enclosures, and supporting structures shall be grounded.

Exception: If isolated from ground and located such that any person in contact with ground cannot contact such metal parts when the equipment is energized, the metal parts shall not be required to be grounded.

Informational Note: See 250.110, Exception No. 2, for pole-mounted distribution apparatus.

(B) **Grounding Electrode Conductor.** If a grounding electrode conductor connects non-current-carrying metal parts to ground, the grounding electrode conductor shall be sized in accordance with Table 250.66, based on the size of the largest ungrounded service, feeder, or branch-circuit conductors supplying the equipment. The grounding electrode conductor shall not be smaller than 6 AWG copper or 4 AWG aluminum or copper-clad aluminum.

(C) **Equipment Grounding Conductor.** Equipment grounding conductors shall comply with 250.190(C)(1) through (C)(3).

(1) **General.** Equipment grounding conductors that are not an integral part of a cable assembly shall not be smaller than 6 AWG copper or 4 AWG aluminum or copper-clad aluminum.

(2) **Shielded Cables.** The metallic insulation shield encircling the current-carrying conductors shall be permitted to be used as an equipment grounding conductor, if it is rated for clearing time of ground-fault current protective device operation without damaging the metallic shield. The metallic tape insulation shield and drain wire insulation shield shall not be used as an equipment grounding conductor for solidly grounded systems.

(3) **Sizing.** Equipment grounding conductors shall be sized in accordance with Table 250.122 based on the current rating of the fuse or the overcurrent setting of the protective relay.

Informational Note: The overcurrent rating for a circuit breaker is the combination of the current transformer ratio and the current pickup setting of the protective relay.

250.191 Grounding System at Alternating-Current Substations. For ac substations, the grounding system shall be in accordance with Part III of this article.

Informational Note: See IEEE 80, *IEEE Guide for Safety in AC Substation Grounding*, for further information on outdoor ac substation grounding.

250.194 Grounding and Bonding of Fences and Other Metal Structures. Metal fences enclosing, and other metal structures in or surrounding, a substation with exposed electrical conductors and equipment shall be grounded and bonded to limit step, touch, and transfer voltages.

(A) Metal Fences. If metal fences are located within 5 m (16 ft) of the exposed electrical conductors or equipment, the fence shall be bonded to the grounding electrode system with wire-type bonding jumpers as follows:

- (1) Bonding jumpers shall be installed at each fence corner and at maximum 50 m (160 ft) intervals along the fence.

- (2) If bare overhead conductors cross the fence, bonding jumpers shall be installed on each side of the crossing.
- (3) Gates shall be bonded to the gate support post, and each gate support post shall be bonded to the grounding electrode system.
- (4) Any gate or other opening in the fence shall be bonded across the opening by a buried bonding jumper.
- (5) The grounding grid or grounding electrode systems shall be extended to cover the swing of all gates.
- (6) The barbed wire strands above the fence shall be bonded to the grounding electrode system.

Alternate designs performed under engineering supervision shall be permitted for grounding or bonding of metal fences.

Informational Note No. 1: A nonconducting fence or section may provide isolation for transfer of voltage to other areas.

Informational Note No. 2: See IEEE 80, *IEEE Guide for Safety In AC Substation Grounding*, for design and installation of fence grounding.

(B) Metal Structures. All exposed conductive metal structures, including guy wires within 2.5 m (8 ft) vertically or 5 m (16 ft) horizontally of exposed conductors or equipment and subject to contact by persons, shall be bonded to the grounding electrode systems in the area.

Chapter 3 Wiring Methods and Materials

ARTICLE 300

General Requirements for Wiring Methods and Materials

300.1 Scope.

(A) **All Wiring Installations.** This article covers general requirements for wiring methods and materials for all wiring installations unless modified by other articles in Chapter 3.

(B) **Integral Parts of Equipment.** The requirements of this article are not intended to apply to the conductors that form an integral part of equipment, such as motors, controllers, motor control centers, or factory-assembled control equipment or listed utilization equipment.

(C) **Metric Designators and Trade Sizes.** Metric designators and trade sizes for conduit, tubing, and associated fittings and accessories shall be in accordance with Table 300.1(C).

300.2 Limitations.

(A) **Voltage.** Wiring methods specified in Chapter 3 shall be used for 1000 volts ac, 1500 volts dc, nominal, or less where not specifically limited elsewhere in Chapter 3. They shall be permitted for over 1000 volts ac, 1500 volts dc, nominal, where specifically permitted elsewhere in this Code.

(B) **Temperature.** Temperature limitation of conductors shall be in accordance with 310.14(A)(3).

300.3 Conductors.

(A) **Single Conductors.** Single conductors specified in Table 310.4(1) shall only be permitted where installed as part of a recognized wiring method specified in Chapter 3.

Exception: Individual conductors shall be permitted where installed as separate overhead conductors in accordance with 225.6.

Table 300.1(C) Metric Designators and Trade Sizes

Metric Designator	Trade Size
12	$\frac{3}{8}$
16	$\frac{1}{2}$
21	$\frac{3}{4}$
27	1
35	1 $\frac{1}{4}$
41	1 $\frac{1}{2}$
53	2
63	2 $\frac{1}{2}$
78	3
91	3 $\frac{1}{2}$
103	4
129	5
155	6

Note: The metric designators and trade sizes are for identification purposes only and are not actual dimensions.

Δ (B) **Conductors of the Same Circuit.** All conductors of the same circuit and, where used, the grounded conductor and all equipment grounding conductors and bonding conductors shall be contained within the same raceway, conduit body, auxiliary gutter, cable tray, cablebus assembly, trench, cable, or cord unless otherwise permitted in accordance with 300.3(B)(1) through (B)(4).

Δ (1) **Paralleled Installations.** Conductors shall be permitted to be run in parallel in accordance with 310.10(G). The requirement to run all circuit conductors within the same raceway, auxiliary gutter, cable tray, trench, cable, or cord shall apply separately to each portion of the paralleled installation, and the equipment grounding conductors shall comply with 250.122. Connections, taps, or extensions made from paralleled conductors shall connect to all conductors of the paralleled set, grounded and ungrounded, as applicable. Parallel runs in cable trays shall comply with 392.20(C).

Exception: Conductors installed in nonmetallic raceways run underground shall be permitted to be arranged as isolated phase, neutral, and grounded conductor installations. The raceways shall be installed in close proximity, and the isolated phase, neutral, and grounded conductors shall comply with 300.20(B).

Δ (2) **Grounding and Bonding Conductors.** Equipment grounding conductors shall be permitted to be installed outside a raceway or cable assembly in accordance with 250.130(C) for certain existing installations or in accordance with 250.134, Exception No. 2, for dc circuits. Equipment bonding conductors shall be permitted to be installed on the outside of raceways in accordance with 250.102(E).

(3) **Nonferrous Wiring Methods.** Conductors in wiring methods with a nonmetallic or other nonmagnetic sheath, where run in different raceways, auxiliary gutters, cable trays, trenches, cables, or cords, shall comply with 300.20(B). Conductors in single-conductor Type MI cable with a nonmagnetic sheath shall comply with 332.31. Conductors of single-conductor Type MC cable with a nonmagnetic sheath shall comply with 330.31, 330.116, and 300.20(B).

(4) **Column-Width Panelboard Enclosures.** Where an auxiliary gutter runs between a column-width panelboard and a pull box, and the pull box includes neutral terminations, the neutral conductors of circuits supplied from the panelboard shall be permitted to originate in the pull box.

(C) Conductors of Different Systems.

Δ (1) **1000 Volts ac, 1500 volts dc, Nominal, or Less.** Conductors of ac and dc circuits rated 1000 volts ac, 1500 volts dc, nominal, or less shall be permitted to occupy the same equipment wiring enclosure, cable, or raceway. All conductors shall have an insulation rating equal to at least the maximum circuit voltage applied to any conductor within the enclosure, cable, or raceway.

Secondary wiring to electric-discharge lamps of 1000 volts ac, 1500 volts dc, or less, if insulated for the secondary voltage involved, shall be permitted to occupy the same luminaire, sign, or outline lighting enclosure as the branch-circuit conductors.

Informational Note No. 1: See 725.136(A) for Class 2 and Class 3 circuit conductors.

Informational Note No. 2: See 690.31(B) for photovoltaic source and output circuits.

- Δ (2) Over 1000 Volts ac, 1500 Volts dc, Nominal.** Conductors of circuits rated over 1000 volts ac, 1500 volts dc, nominal, shall not occupy the same equipment wiring enclosure, cable, or raceway with conductors of circuits rated 1000 volts ac, 1500 volts dc, nominal, or less unless permitted in accordance with 305.4.

300.4 Protection Against Physical Damage. Where subject to physical damage, conductors, raceways, and cables shall be protected.

(A) Cables and Raceways Through Wood Members.

- Δ (1) Bored Holes.** In both exposed and concealed locations, where a cable- or raceway-type wiring method is installed through bored holes in joists, rafters, or wood members, holes shall be bored so that the edge of the hole is not less than 32 mm (1¼ in.) from the edges of the wood member. Where this distance cannot be maintained, the cable or raceway shall be protected from penetration by screws or nails by a steel plate(s) or bushing(s) at least 1.6 mm (⅙ in.) thick, and of appropriate length and width, installed to cover the area of the wiring.

Exception No. 1: Steel plates shall not be required to protect rigid metal conduit, intermediate metal conduit, rigid PVC conduit, RTRC, or electrical metallic tubing.

Exception No. 2: A listed and marked steel plate less than 1.6 mm (⅙ in.) thick that provides equal or better protection against nail or screw penetration shall be permitted.

(2) Notches in Wood. Where there is no objection because of weakening the building structure, in both exposed and concealed locations, cables or raceways shall be permitted to be laid in notches in wood studs, joists, rafters, or other wood members where the cable or raceway at those points is protected from penetration by nails or screws by a steel plate at least 1.6 mm (⅙ in.) thick, and of appropriate length and width, installed to cover the area of the wiring. The steel plate shall be installed before the building finish is applied.

Exception No. 1: Steel plates shall not be required to protect rigid metal conduit, intermediate metal conduit, rigid nonmetallic conduit, or electrical metallic tubing.

Exception No. 2: A listed and marked steel plate less than 1.6 mm (⅙ in.) thick that provides equal or better protection against nail or screw penetration shall be permitted.

(B) Nonmetallic-Sheathed Cables and Electrical Nonmetallic Tubing Through Metal Framing Members.

(1) Nonmetallic-Sheathed Cable. In both exposed and concealed locations where nonmetallic-sheathed cables pass through either factory- or field-punched, cut, or drilled slots or holes in metal members, the cable shall be protected by listed bushings or listed grommets covering all metal edges that are securely fastened in the opening prior to installation of the cable.

(2) Nonmetallic-Sheathed Cable and Electrical Nonmetallic Tubing. Where nails or screws are likely to penetrate nonmetallic-sheathed cable or electrical nonmetallic tubing, a

steel sleeve, steel plate, or steel clip not less than 1.6 mm (⅙ in.) in thickness shall be used to protect the cable or tubing.

Exception: A listed and marked steel plate less than 1.6 mm (⅙ in.) thick that provides equal or better protection against nail or screw penetration shall be permitted.

- Δ (C) Cables Through Spaces Behind Panels Designed to Allow Access.** Cables or raceway-type wiring methods, installed behind panels designed to allow access shall be supported according to their applicable articles.

(D) Cables and Raceways Parallel to Framing Members and Furring Strips. In both exposed and concealed locations, where a cable- or raceway-type wiring method is installed parallel to framing members, such as joists, rafters, or studs, or is installed parallel to furring strips, the cable or raceway shall be installed and supported so that the nearest outside surface of the cable or raceway is not less than 32 mm (1¼ in.) from the nearest edge of the framing member or furring strips where nails or screws are likely to penetrate. Where this distance cannot be maintained, the cable or raceway shall be protected from penetration by nails or screws by a steel plate, sleeve, or equivalent at least 1.6 mm (⅙ in.) thick.

Exception No. 1: Steel plates, sleeves, or the equivalent shall not be required to protect rigid metal conduit, intermediate metal conduit, rigid nonmetallic conduit, or electrical metallic tubing.

Exception No. 2: For concealed work in finished buildings, or finished panels for prefabricated buildings where such supporting is impracticable, it shall be permissible to fish the cables between access points.

Exception No. 3: A listed and marked steel plate less than 1.6 mm (⅙ in.) thick that provides equal or better protection against nail or screw penetration shall be permitted.

- Δ (E) Cables, Raceways, or Boxes Installed in or Under Metal-Corrugated Roof Decking.** A cable, raceway, or box, installed in exposed or concealed locations under metal-corrugated sheet roof decking, shall be installed and supported so there is not less than 38 mm (1½ in.) measured from the lowest surface of the roof decking to the top of the cable, raceway, or box. A cable, raceway, or box shall not be installed in concealed locations in metal-corrugated, sheet decking-type roof.

Informational Note: Roof decking material is often repaired or replaced after the initial raceway or cabling and roofing installation and might be penetrated by screws or other mechanical devices designed to provide “hold down” strength of the waterproof membrane or roof insulating material.

Exception No. 1: Rigid metal conduit and intermediate metal conduit, with listed steel or malleable iron fittings and boxes, shall not be required to comply with 300.4(E).

Exception No. 2: The 38 mm (1½ in.) spacing is not required where metal-corrugated sheet roof decking is covered with a minimum thickness 50 mm (2 in.) concrete slab, measured from the top of the corrugated roofing.

(F) Cables and Raceways Installed in Shallow Grooves. Cable- or raceway-type wiring methods installed in a groove, to be covered by wallboard, siding, paneling, carpeting, or similar finish, shall be protected by 1.6 mm (⅙ in.) thick steel plate, sleeve, or equivalent or by not less than 32-mm (1¼-in.) free space for the full length of the groove in which the cable or raceway is installed.

Exception No. 1: Steel plates, sleeves, or the equivalent shall not be required to protect rigid metal conduit, intermediate metal conduit, rigid PVC conduit, RTRC, or electrical metallic tubing.

Exception No. 2: A listed and marked steel plate less than 1.6 mm ($\frac{1}{16}$ in.) thick that provides equal or better protection against nail or screw penetration shall be permitted.

(G) Fittings. Where raceways contain 4 AWG or larger insulated circuit conductors, and these conductors enter a cabinet, a box, an enclosure, or a raceway, prior to the installation of conductors, the conductors shall be protected in accordance with any of the following:

- (1) An identified fitting providing a smoothly rounded insulating surface
- (2) A listed metal fitting that has smoothly rounded edges
- (3) Separation from the fitting or raceway using an identified insulating material that is securely fastened in place
- (4) Threaded hubs or bosses that are an integral part of a cabinet, box, enclosure, or raceway providing a smoothly rounded or flared entry for conductors

Conduit bushings constructed wholly of insulating material shall not be used to secure a fitting or raceway. The insulating fitting or insulating material shall have a temperature rating not less than the insulation temperature rating of the installed conductors.

(H) Structural Joints. A listed expansion/deflection fitting or other approved means shall be used where a raceway crosses a structural joint intended for expansion, contraction, or deflection, used in buildings, bridges, parking garages, or other structures.

300.5 Underground Installations.

(A) Minimum Cover Requirements. Direct-buried cable, conduit, or other raceways shall be installed to meet the minimum cover requirements of Table 300.5(A).

(B) Wet Locations. The interior of enclosures or raceways installed underground shall be considered to be a wet location. Insulated conductors and cables installed in these enclosures or raceways in underground installations shall comply with 310.10(C).

(C) Underground Cables and Conductors Under Buildings. Underground cable and conductors installed under a building shall be in a raceway.

Exception No. 1: Type MI cable shall be permitted under a building without installation in a raceway where embedded in concrete, fill, or other masonry in accordance with 332.10(6) or in underground runs where suitably protected against physical damage and corrosive conditions in accordance with 332.10(10).

Exception No. 2: Type MC cable listed for direct burial or concrete encasement shall be permitted under a building without installation in a raceway in accordance with 330.10(A)(5) and in wet locations in accordance with 330.10(A)(11).

(D) Protection from Damage. Conductors and cables shall be protected from damage in accordance with 300.5(D)(1) through (D)(4).

(1) Emerging from Grade. Direct-buried conductors and cables emerging from grade and specified in Columns 1 and 4 of Table 300.5(A) shall be protected by enclosures or raceways extending from the minimum cover distance below grade

required by 300.5(A) to a point at least 2.5 m (8 ft) above finished grade. In no case shall the protection be required to exceed 450 mm (18 in.) below finished grade.

(2) Conductors Entering Buildings. Conductors entering a building shall be protected to the point of entrance.

(3) Service Conductors. Underground service conductors that are not encased in concrete and that are buried 450 mm (18 in.) or more below grade shall have their location identified by a warning ribbon that is placed in the trench at least 300 mm (12 in.) above the underground installation.

(4) Enclosure or Raceway Damage. Where the enclosure or raceway is subject to physical damage, the conductors shall be installed in electrical metallic tubing, rigid metal conduit, intermediate metal conduit, RTRC-XW, Schedule 80 PVC conduit, or equivalent.

(E) Splices and Taps. Direct-buried conductors or cables shall be permitted to be spliced or tapped without the use of splice boxes. The splices or taps shall be made in accordance with 110.14(B).

(F) Backfill. Backfill that contains large rocks, paving materials, cinders, large or sharply angular substances, or corrosive material shall not be placed in an excavation where materials might damage raceways, cables, conductors, or other substructures or prevent adequate compaction of fill or contribute to corrosion of raceways, cables, or other substructures.

Where necessary to prevent physical damage to the raceway, cable, or conductor, protection shall be provided in the form of granular or selected material, suitable running boards, suitable sleeves, or other approved means.

(G) Raceway Seals. Conduits or raceways through which moisture might contact live parts shall be sealed or plugged at either or both ends. Spare or unused raceways shall also be sealed. Sealants shall be identified for use with the cable insulation, conductor insulation, bare conductor, shield, or other components.

Informational Note: Presence of hazardous gases or vapors might also necessitate the sealing of underground conduits or raceways entering buildings.

(H) Bushing. A bushing, or terminal fitting, with an integral bushed opening shall be used at the end of a conduit or other raceway that terminates underground where the conductors or cables emerge as a direct burial wiring method. A seal incorporating the physical protection characteristics of a bushing shall be permitted to be used in lieu of a bushing.

(I) Conductors of the Same Circuit. All conductors of the same circuit and, where used, the grounded conductor and all equipment grounding conductors shall be installed in the same raceway or cable or shall be installed in close proximity in the same trench.

Exception No. 1: Conductors shall be permitted to be installed in parallel in raceways, multiconductor cables, or direct-buried single conductor cables. Each raceway or multiconductor cable shall contain all conductors of the same circuit, including equipment grounding conductors. Each direct-buried single conductor cable shall be located in close proximity in the trench to the other single conductor cables in the same parallel set of conductors in the circuit, including equipment grounding conductors.

Table 300.5(A) Minimum Cover Requirements, 0 to 1000 Volts ac, 1500 Volts dc, Nominal, Burial in Millimeters (Inches)

Location of Wiring Method or Circuit	Type of Wiring Method or Circuit									
	Column 1 Direct Burial Cables or Conductors		Column 2 Rigid Metal Conduit or Intermediate Metal Conduit		Column 3 Electrical Metallic Tubing, Nonmetallic Raceways Listed for Direct Burial Without Concrete Encasement, or Other Approved Raceways		Column 4 Residential Branch Circuits Rated 120 Volts or Less with GFCI Protection and Maximum Overcurrent Protection of 20 Amperes		Column 5 Circuits for Control of Irrigation and Landscape Lighting Limited to Not More Than 30 Volts and Installed with Type UF or in Other Identified Cable or Raceway	
	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
All locations not specified below	600	24	150	6	450	18	300	12	150 ^{1,2}	6 ^{1,2}
In trench below 50 mm (2 in.) thick concrete or equivalent	450	18	150	6	300	12	150	6	150	6
Under a building	0	0 (in raceway or Type MC or Type MI cable identified for direct burial)	0	0	0	0	0	0 (in raceway or Type MC or Type MI cable identified for direct burial)	0	0 (in raceway or Type MC or Type MI cable identified for direct burial)
Under minimum of 102 mm (4 in.) thick concrete exterior slab with no vehicular traffic and the slab extending not less than 152 mm (6 in.) beyond the underground installation	450	18	100	4	100	4	150 (direct burial) 100 (in raceway)	6 4	150 (direct burial) 100 (in raceway)	6 4
Under streets, highways, roads, alleys, driveways, and parking lots	600	24	600	24	600	24	600	24	600	24
One- and two-family dwelling driveways and outdoor parking areas, and used only for dwelling- related purposes	450	18	450	18	450	18	300	12	450	18
In or under airport runways, including adjacent areas where trespassing is prohibited	450	18	450	18	450	18	450	18	450	18

¹A lesser depth shall be permitted where specified in the installation instructions of a listed low-voltage lighting system.

²A depth of 150 mm (6 in.) shall be permitted for pool, spa, and fountain lighting, installed in a nonmetallic raceway, limited to not more than 30 volts where part of a listed low-voltage lighting system.

Notes:

1. Cover shall be defined as the shortest distance in mm (in.) measured between a point on the top surface of any direct-buried conductor, cable, conduit, or other raceway and the top surface of finished grade, concrete, or similar cover.
2. Raceways approved for burial only where concrete encased shall require a concrete envelope not less than 50 mm (2 in.) thick.
3. Lesser depths shall be permitted where cables and conductors rise for terminations or splices or where access is otherwise required.
4. Where one of the wiring method types listed in Columns 1 through 3 is used for one of the circuit types in Columns 4 and 5, the shallowest depth of burial shall be permitted.
5. Where solid rock prevents compliance with the cover depths specified in this table, the wiring shall be installed in a metal raceway, or a nonmetallic raceway permitted for direct burial. The raceways shall be covered by a minimum of 50 mm (2 in.) of concrete extending down to rock.
6. Directly buried electrical metallic tubing (EMT) shall comply with 358.10.

Exception No. 2: Isolated phase, polarity, grounded conductor, and equipment grounding and bonding conductor installations shall be permitted in nonmetallic raceways or cables with a nonmetallic covering or nonmagnetic sheath in close proximity where conductors are paralleled as permitted in 310.10(G), and where the conditions of 300.20(B) are met.

(J) Earth Movement. Where direct-buried conductors, raceways, or cables are subject to movement by settlement or frost, direct-buried conductors, raceways, or cables shall be arranged

so as to prevent damage to the enclosed conductors or to equipment connected to the raceways.

Informational Note: This section recognizes “S” loops in underground direct burial cables and conductors to raceway transitions, expansion fittings in raceway risers to fixed equipment, and, generally, the provision of flexible connections to equipment subject to settlement or frost heaves.

(K) Directional Boring. Cables or raceways installed using directional boring equipment shall be approved for the purpose.

300.6 Protection Against Corrosion and Deterioration. Raceways, cable trays, cablebus, auxiliary gutters, cable armor, boxes, cable sheathing, cabinets, enclosures (other than surrounding fences and walls), elbows, couplings, fittings, supports, and support hardware shall be of materials suitable for the environment in which they are to be installed.

Δ (A) Ferrous Metal Equipment. Ferrous metal raceways, cable trays, cablebus, auxiliary gutters, cable armor, boxes, cable sheathing, cabinets, enclosures (other than surrounding fences and walls), elbows, couplings, nipples, fittings, supports, and support hardware shall be suitably protected against corrosion inside and outside (except threads at joints) by a coating of approved corrosion-resistant material. Where corrosion protection is necessary and the conduit is threaded anywhere other than at the factory where the product is listed, the threads shall be coated with an approved electrically conductive, corrosion-resistant compound.

Exception: Stainless steel shall not be required to have protective coatings.

(1) Protected from Corrosion Solely by Enamel. Where protected from corrosion solely by enamel, ferrous metal raceways, cable trays, cablebus, auxiliary gutters, cable armor, boxes, cable sheathing, cabinets, enclosures (other than surrounding fences and walls), elbows, couplings, nipples, fittings, supports, and support hardware shall not be used outdoors or in wet locations as described in 300.6(D).

(2) Organic Coatings on Boxes or Cabinets. Where boxes, cabinets, or enclosures (other than surrounding fences and walls) have an approved system of organic coatings and are marked "Raintight," "Rainproof," or "Outdoor Type," they shall be permitted outdoors.

Δ (3) In Concrete or in Direct Contact with the Earth. Ferrous metal raceways, cable armor, boxes, cable sheathing, cabinets, enclosures (other than surrounding fences and walls), elbows, couplings, nipples, fittings, supports, and support hardware shall be permitted to be installed in concrete, in direct contact with the earth, or in areas subject to severe corrosive influences where made of material approved for the condition or where provided with corrosion protection approved for the condition.

(B) Aluminum Metal Equipment. Aluminum raceways, cable trays, cablebus, auxiliary gutters, cable armor, boxes, cable sheathing, cabinets, enclosures (other than surrounding fences and walls), elbows, couplings, nipples, fittings, supports, and support hardware embedded or encased in concrete or in direct contact with the earth shall be provided with supplementary corrosion protection.

(C) Nonmetallic Equipment. Nonmetallic raceways, cable trays, cablebus, auxiliary gutters, boxes, cables with a nonmetallic outer jacket and internal metal armor or jacket, cable sheathing, cabinets, enclosures (other than surrounding fences and walls), elbows, couplings, nipples, fittings, supports, and support hardware shall be made of material approved for the condition and shall comply with 300.6(C)(1) and (C)(2) as applicable to the specific installation.

(1) Exposed to Sunlight. Where exposed to sunlight, the materials shall be listed as sunlight resistant or shall be identified as sunlight resistant.

(2) Chemical Exposure. Where subject to exposure to chemical solvents, vapors, splashing, or immersion, materials or coatings shall either be inherently resistant to chemicals based on their listing or be identified for the specific chemical reagent.

(D) Indoor Wet Locations. In portions of dairy processing facilities, laundries, canneries, and other indoor wet locations, and in locations where walls are frequently washed or where there are surfaces of absorbent materials, such as damp paper or wood, the entire wiring system, where installed exposed, including all boxes, cabinets, enclosures (other than surrounding fences and walls), fittings, raceways, and cable used therein, shall be mounted so that there is at least a 6 mm (¼ in.) airspace between it and the wall or supporting surface.

Exception: Nonmetallic raceways, boxes, and fittings shall be permitted to be installed without the airspace on a concrete, masonry, tile, or similar surface.

Informational Note: In general, areas where acids and alkali chemicals are handled and stored might present such corrosive conditions, particularly when wet or damp. Severe corrosive conditions might also be present in portions of meatpacking plants, tanneries, glue houses, and some stables; in installations immediately adjacent to a seashore and swimming pool areas; in areas where chemical deicers are used; and in storage cellars or rooms for hides, casings, fertilizer, salt, and bulk chemicals.

300.7 Raceways Exposed to Different Temperatures.

(A) Sealing. Where portions of a raceway or sleeve are known to be subjected to different temperatures, and where condensation is known to be a problem, as in cold storage areas of buildings or where passing from the interior to the exterior of a building, the raceway or sleeve shall be sealed to prevent the circulation of warm air to a colder section of the raceway or sleeve. Sealants shall be identified for use with cable insulation, conductor insulation, a bare conductor, a shield, or other components. An explosionproof seal shall not be required for this purpose.

(B) Expansion, Expansion-Deflection, and Deflection Fittings. Raceways shall be provided with expansion, expansion-deflection, or deflection fittings where necessary to compensate for thermal expansion, deflection, and contraction.

Informational Note No. 1: Table 352.44(A) and Table 355.44 provide the expansion information for polyvinyl chloride (PVC) and for reinforced thermosetting resin conduit (RTRC), respectively. A nominal number for steel conduit can be determined by multiplying the expansion length in Table 352.44(A) by 0.20. The coefficient of expansion for steel electrical metallic tubing, intermediate metal conduit, and rigid metal conduit is 1.170×10^{-5} (0.0000117 mm per mm of conduit for each °C in temperature change) [0.650×10^{-5} (0.0000065 in. per in. of conduit for each °F in temperature change)].

A nominal number for aluminum conduit and aluminum electrical metallic tubing can be determined by multiplying the expansion length in Table 352.44(A) by 0.40. The coefficient of expansion for aluminum electrical metallic tubing and aluminum rigid metal conduit is 2.34×10^{-5} (0.0000234 mm per mm of conduit for each °C in temperature change) [1.30×10^{-5} (0.000013 in. per in. of conduit for each °F in temperature change)].

Informational Note No. 2: See NEMA FB 2.40-2019, *Installation Guidelines for Expansion and Expansion/Deflection Fittings*, for

further information on expansion and expansion deflection fittings.

300.8 Installation of Conductors With Other Systems. Raceways or cable trays containing electrical conductors shall not contain any pipe, tube, or equal for steam, water, air, gas, drainage, or any service other than electrical.

300.9 Raceways in Wet Locations Above Grade. Where raceways are installed in wet locations above grade, the interior of these raceways shall be considered to be a wet location. Insulated conductors and cables installed in raceways in wet locations above grade shall comply with 310.10(C).

Δ 300.10 Electrical Continuity of Metal Raceways, Cable Armor, and Enclosures. Metal raceways, cable armor, and other metal enclosures for conductors shall be metallically joined together into a continuous electrical conductor and shall be connected to all boxes, fittings, and cabinets to provide effective electrical continuity. Unless specifically permitted elsewhere in this *Code*, raceways and cable assemblies shall be mechanically secured to boxes, fittings, cabinets, and other enclosures.

Exception No. 1: Short sections of raceways used to provide support or protection of cable assemblies from physical damage shall not be required to be made electrically continuous.

Exception No. 2: Equipment enclosures to be isolated, as permitted by 250.96(B), shall not be required to be metallically joined to the metal raceway.

300.11 Securing and Supporting.

(A) Secured in Place. Raceways, cable assemblies, boxes, cabinets, and fittings shall be securely fastened in place.

Δ (B) Wiring Systems Installed Above Suspended Ceilings. Support wires that do not provide secure support shall not be the sole support. Support wires and associated fittings that provide secure support and that are installed in addition to the ceiling grid support wires shall be permitted as the sole support. Where independent support wires are used, they shall be secured at both ends. Cables and raceways shall not be supported by ceiling grids.

(1) Fire-Rated Assemblies. Wiring located within the cavity of a fire-rated floor-ceiling or roof-ceiling assembly shall not be secured to, or supported by, the ceiling assembly, including the ceiling support wires. An independent means of secure support shall be provided and shall be permitted to be attached to the assembly. Where independent support wires are used, they shall be distinguishable by color, tagging, or other effective means from those that are part of the fire-rated design.

Exception: The ceiling support system shall be permitted to support wiring and equipment that have been tested as part of the fire-rated assembly.

Informational Note: See ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, for one method of testing to determine fire rating.

(2) Non-Fire-Rated Assemblies. Wiring located within the cavity of a non-fire-rated floor-ceiling or roof-ceiling assembly shall not be secured to, or supported by, the ceiling assembly, including the ceiling support wires. An independent means of secure support shall be provided and shall be permitted to be attached to the assembly. Where independent support wires are used, they shall be distinguishable by color, tagging, or other effective means.

Exception: The ceiling support system shall be permitted to support branch-circuit wiring and associated equipment where installed in accordance with the ceiling system manufacturer's instructions.

(C) Raceways Used as Means of Support. Raceways shall be used only as a means of support for other raceways, cables, or nonelectrical equipment under any of the following conditions:

- (1) Where the raceway or means of support is identified as a means of support
- (2) Where the raceway contains power supply conductors for electrically controlled equipment and is used to support Class 2 or Class 3 circuit conductors or cables that are solely for the purpose of connection to the equipment control circuits
- (3) Where the raceway is used to support boxes or conduit bodies in accordance with 314.23 or to support luminaires in accordance with 410.36(E)

(D) Cables Not Used as Means of Support. Cable wiring methods shall not be used as a means of support for other cables, raceways, or nonelectrical equipment.

300.12 Mechanical Continuity — Raceways and Cables. Raceways, cable armors, and cable sheaths shall be continuous between cabinets, boxes, conduit bodies, fittings, or other enclosures or outlets.

Exception No. 1: Short sections of raceways used to provide support or protection of cable assemblies from physical damage shall not be required to be mechanically continuous.

Exception No. 2: Raceways and cables installed into the bottom of open bottom equipment, such as switchboards, motor control centers, and floor or pad-mounted transformers, shall not be required to be mechanically secured to the equipment.

300.13 Mechanical and Electrical Continuity — Conductors.

(A) General. Conductors in raceways shall be continuous between outlets, boxes, devices, and so forth. There shall be no splice or tap within a raceway unless permitted by 300.15, 368.56(A), 376.56, 378.56, 384.56, 386.56, 388.56, or 390.56.

Δ (B) Device Removal. In multiwire branch circuits, the continuity of a grounded conductor shall not depend on device connections such as lampholders, receptacles, and so forth where the removal of such devices would interrupt the continuity.

300.14 Length of Free Conductors at Outlets, Junctions, and Switch Points. At least 150 mm (6 in.) of free conductor, measured from the point in the box where it emerges from its raceway or cable sheath, shall be left at each outlet, junction, and switch point for splices or the connection of luminaires or devices. The 150 mm (6 in.) free conductor shall be permitted to be spliced or unspliced. Where the opening to an outlet, junction, or switch point is less than 200 mm (8 in.) in any dimension, each conductor shall be long enough to extend at least 75 mm (3 in.) outside the opening.

Exception: Conductors that are not spliced or terminated at the outlet, junction, or switch point shall not be required to comply with 300.14.

Δ 300.15 Boxes, Conduit Bodies, or Fittings — Where Required. A box shall be installed at each outlet and switch point for concealed knob-and-tube wiring.

Fittings and connectors shall be used only with the specific wiring methods for which they are designed and listed.

Where the wiring method is conduit, tubing, Type AC cable, Type MC cable, Type MI cable, nonmetallic-sheathed cable, or other cables, a box or conduit body shall be installed at each outlet point, switch point, conductor splice point, conductor junction point, conductor termination point, wiring method transition point, or conductor pull point, unless otherwise permitted in 300.15(A) through (L).

(A) Wiring Methods with Interior Access. A box or conduit body shall not be required for each splice, junction, switch, pull, termination, or outlet points in wiring methods with removable covers, such as wireways, multioutlet assemblies, auxiliary gutters, and surface raceways. The covers shall be accessible after installation.

(B) Equipment. An integral junction box or wiring compartment as part of approved equipment shall be permitted in lieu of a box.

(C) Protection. A box or conduit body shall not be required where cables enter or exit from conduit or tubing that is used to provide cable support or protection against physical damage. A fitting shall be provided on the end(s) of the conduit or tubing to protect the cable from abrasion.

(D) Type MI Cable. A box or conduit body shall not be required where accessible fittings are used for straight-through splices in mineral-insulated metal-sheathed cable.

(E) Integral Enclosure. A wiring device with integral enclosure identified for the use, having brackets that securely fasten the device to walls or ceilings of conventional on-site frame construction, for use with nonmetallic-sheathed cable, shall be permitted in lieu of a box or conduit body.

Informational Note: See 334.30(C); 545.10; 550.15(I); 551.47(E), Exception No. 1; and 552.48(E), Exception No. 1.

(F) Fitting. A fitting identified for the use shall be permitted in lieu of a box or conduit body where conductors are not spliced or terminated within the fitting. The fitting shall be accessible after installation, unless listed for concealed installation.

(G) Direct-Buried Conductors and Cables. As permitted in 300.5(E), a box or conduit body shall not be required for splices and taps in direct-buried conductors and cables.

(H) Insulated Devices. As permitted in 334.40(B), a box or conduit body shall not be required for insulated devices supplied by nonmetallic-sheathed cable.

(I) Enclosures. A box or conduit body shall not be required where a splice, switch, terminal, or pull point is in a cabinet or cutout box, in an enclosure for a switch or overcurrent device as permitted in 312.8, in a motor controller as permitted in 430.10(A), or in a motor control center.

(J) Luminaires. A box or conduit body shall not be required where a luminaire is used as a raceway as permitted in 410.64.

(K) Embedded. A box or conduit body shall not be required for splices where conductors are embedded as permitted in 424.40, 424.41(D), 426.22(C), 426.24(A), and 427.19(A).

Δ (L) Manholes and Handhole Enclosures. A box or conduit body shall not be required for conductors in manholes or

handhole enclosures, except where connecting to electrical equipment. The installation shall comply with Part V of Article 110 for manholes, and 314.30 for handhole enclosures.

300.16 Raceway or Cable to Open or Concealed Wiring.

Δ (A) Box, Conduit Body, or Fitting. A box, conduit body, or terminal fitting having a separately bushed hole for each conductor shall be used wherever a change is made from conduit, electrical metallic tubing, electrical nonmetallic tubing, nonmetallic-sheathed cable, Type AC cable, Type MC cable, or mineral-insulated, metal-sheathed cable and surface raceway wiring to open wiring or to concealed knob-and-tube wiring. A fitting used for this purpose shall contain no taps or splices and shall not be used at luminaire outlets. A conduit body used for this purpose shall contain no taps or splices unless it complies with 314.16(C)(2).

(B) Bushing. A bushing shall be permitted in lieu of a box or terminal where the conductors emerge from a raceway and enter or terminate at equipment, such as open switchboards, unenclosed control equipment, or similar equipment. The bushing shall be of the insulating type for other than lead-sheathed conductors.

Δ 300.17 Number and Size of Conductors and Cables in Raceway. The number and size of conductors and cables in any raceway shall not be more than will permit dissipation of the heat and ready installation or withdrawal of the conductors or cables without damage to the conductors or cables, or to their insulation.

Informational Note: See the following sections of this Code: intermediate metal conduit, 342.22; rigid metal conduit, 344.22; flexible metal conduit, 348.22; liquidtight flexible metal conduit, 350.22; PVC conduit, 352.22; HDPE conduit, 353.22; RTRC, 355.22; liquidtight nonmetallic flexible conduit, 356.22; electrical metallic tubing, 358.22; flexible metallic tubing, 360.22; electrical nonmetallic tubing, 362.22; cellular concrete floor raceways, 372.22; cellular metal floor raceways, 374.22; metal wireways, 376.22; nonmetallic wireways, 378.22; surface metal raceways, 386.22; surface nonmetallic raceways, 388.22; underfloor raceways, 390.22; fixture wire, 402.7; theaters, 520.6; signs, 600.31(C); elevators, 620.33; audio signal processing, amplification, and reproduction equipment, 640.23(A) and 640.24; Class 1 circuits, 724.3(A); Class 2, Class 3, Class 4, and power-limited fire alarm (PLFA) circuits, 722.3(A); non-power-limited fire alarm (NPLFA) circuits, 760.3(H); and optical fiber cables and raceways, 770.110(B).

300.18 Raceway Installations.

Δ (A) Complete Runs. Raceways other than busways, listed manufactured assemblies in accordance with 604.100, or exposed raceways having hinged or removable covers shall be installed complete between outlet, junction, or splicing points prior to the installation of conductors or cables. Where required to facilitate the installation of utilization equipment, the raceway shall be permitted to be initially installed without a terminating connection at the equipment. Prewired raceway assemblies shall be permitted only where specifically permitted in this Code for the applicable wiring method.

Exception: Short sections of raceways used to contain conductors or cable assemblies for protection from physical damage shall not be required to be installed complete between outlet, junction, or splicing points.

(B) Welding. Metal raceways shall not be supported, terminated, or connected by welding to the raceway unless specifically

designed to be or otherwise specifically permitted to be in this Code.

300.19 Supporting Conductors in Vertical Raceways.

(A) Spacing Intervals — Maximum. Conductors in vertical raceways shall be supported if the vertical rise exceeds the values in Table 300.19(A). At least one support method shall be provided for each conductor at the top of the vertical raceway or as close to the top as practical. Intermediate supports shall be provided as necessary to limit supported conductor lengths to not greater than those values specified in Table 300.19(A).

Exception: Steel wire armor cable shall be supported at the top of the riser with a cable support that clamps the steel wire armor. A safety device shall be permitted at the lower end of the riser to hold the cable in the event there is slippage of the cable in the wire-armored cable support. Additional wedge-type supports shall be permitted to relieve the strain on the equipment terminals caused by expansion of the cable under load.

(B) Fire-Resistive Cables and Conductors. Support methods and spacing intervals for fire-resistive cables and conductors shall comply with any restrictions provided in the listing of the electrical circuit protective system or fire-resistive cable system used and in no case shall exceed the values in Table 300.19(A).

(C) Support Methods. One of the following methods of support shall be used:

- (1) Clamping devices constructed of or employing insulating wedges inserted in the ends of the raceways. Where clamping of insulation does not adequately support the cable, the conductor also shall be clamped.
- (2) Inserting boxes at the required intervals in which insulating supports are installed and secured in an approved manner to withstand the weight of the conductors attached thereto, the boxes being provided with covers.
- (3) In junction boxes, deflecting the cables not less than 90 degrees and carrying them horizontally to a distance not less than twice the diameter of the cable, with the cables being carried on two or more insulating supports and additionally secured thereto by tie wires, if desired. Where this method is used, cables shall be supported at intervals not greater than 20 percent of the support spacing in Table 300.19(A).
- (4) Other approved means.

300.20 Induced Currents in Ferrous Metal Enclosures or Ferrous Metal Raceways.

Δ (A) Conductors Grouped Together. Where conductors carrying alternating current are installed in ferrous metal enclosures or ferrous metal raceways, they shall be arranged so as to avoid heating the surrounding ferrous metal by induction. To accomplish this, all phase conductors and, where used, the grounded conductor and all equipment grounding conductors shall be grouped together.

Exception No. 1: Equipment grounding conductors for certain existing installations shall be permitted to be installed separate from their associated circuit conductors where run in accordance with 250.130(C).

Exception No. 2: A single conductor shall be permitted to be installed in a ferromagnetic enclosure and used for skin-effect heating in accordance with 426.42 and 427.47.

Δ (B) Individual Conductors. Where a single conductor carrying alternating current passes through metal with magnetic properties, the inductive effect shall be minimized by either cutting slots in the metal between the individual holes through which the individual conductors pass or passing all the conductors in the circuit through an insulating wall sufficiently large for all of the conductors of the circuit.

Exception: In the case of circuits supplying vacuum or electric-discharge lighting systems or signs or X-ray apparatus, the currents carried by the conductors are so small that the inductive heating effect can be ignored where these conductors are placed in metal enclosures or pass through metal.

Informational Note: Because aluminum is not a magnetic metal, there will be no heating due to hysteresis; however, induced currents will be present. They will not be of sufficient magnitude to require grouping of conductors or special treatment in passing conductors through aluminum wall sections.

300.21 Spread of Fire or Products of Combustion. Electrical installations in hollow spaces, vertical shafts, and ventilation or air-handling ducts shall be made so that the possible spread of fire or products of combustion will not be substantially increased. Openings around electrical penetrations into or through fire-resistant-rated walls, partitions, floors, or ceilings shall be firestopped using approved methods to maintain the fire resistance rating.

Informational Note: Directories of electrical construction materials published by qualified testing laboratories contain many listing installation restrictions necessary to maintain the fire-resistive rating of assemblies where penetrations or openings are

Table 300.19(A) Spacings for Conductor Supports

Conductor Size	Support of Conductors in Vertical Raceways	Conductors			
		Aluminum or Copper-Clad Aluminum		Copper	
		m	ft	m	ft
18 AWG through 8 AWG	Not greater than	30	100	30	100
6 AWG through 1/0 AWG	Not greater than	60	200	30	100
2/0 AWG through 4/0 AWG	Not greater than	55	180	25	80
Over 4/0 AWG through 350 kcmil	Not greater than	41	135	18	60
Over 350 kcmil through 500 kcmil	Not greater than	36	120	15	50
Over 500 kcmil through 750 kcmil	Not greater than	28	95	12	40
Over 750 kcmil	Not greater than	26	85	11	35

made. Building codes also contain restrictions on membrane penetrations on opposite sides of a fire-resistance-rated wall assembly. An example is the 600-mm (24-in.) minimum horizontal separation that usually applies between boxes installed on opposite sides of the wall. Assistance in complying with the requirements of 300.21 can be found in building codes, fire resistance directories, and product listings.

300.22 Wiring in Ducts Not Used for Air Handling, Fabricated Ducts for Environmental Air, and Other Spaces for Environmental Air (Plenums). The requirements of this section shall apply to the installation and uses of electrical wiring and equipment in ducts used for dust, loose stock, or vapor removal; ducts specifically fabricated for environmental air; and other spaces used for environmental air (plenums).

Informational Note: See Part VI of Article 424 for requirements on duct heaters.

(A) Ducts for Dust, Loose Stock, or Vapor Removal. 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.

(B) Ducts Specifically Fabricated for Environmental Air. Equipment, devices, and the wiring methods specified in this section shall be permitted within such ducts only if necessary for the direct action upon, or sensing of, the contained air. Where equipment or devices are installed and illumination is necessary to facilitate maintenance and repair, enclosed gasketed-type luminaires shall be permitted.

Only wiring methods consisting of Type MI cable without an overall nonmetallic covering, Type MC cable employing a smooth or corrugated impervious metal sheath without an overall nonmetallic covering, electrical metallic tubing, flexible metallic tubing, intermediate metal conduit, or rigid metal conduit without an overall nonmetallic covering shall be installed in ducts specifically fabricated to transport environmental air. Flexible metal conduit shall be permitted, in lengths not to exceed 1.2 m (4 ft), to connect physically adjustable equipment and devices permitted to be in these fabricated ducts. The connectors used with flexible metal conduit shall effectively close any openings in the connection.

Exception: Wiring methods and cabling systems, listed for use in other spaces used for environmental air (plenums), shall be permitted to be installed in ducts specifically fabricated for environmental air-handling purposes under both of the following conditions:

- (1) *The wiring methods or cabling systems shall be permitted only if necessary to connect to equipment or devices associated with the direct action upon or sensing of the contained air.*
- (2) *The total length of such wiring methods or cabling systems shall not exceed 1.2 m (4 ft).*

Δ (C) Other Spaces Used for Environmental Air (Plenums). This section shall apply to spaces not specifically fabricated for environmental air-handling purposes but used for air-handling purposes as a plenum. This section shall not apply to habitable rooms or areas of buildings, the prime purpose of which is not air handling.

Informational Note No. 1: The space over a hung ceiling used for environmental air-handling purposes is an example of the type of other space to which this section applies.

Informational Note No. 2: See NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, and other mechanical codes for information on how the term *other spaces used for environmental air (plenum)*, as used in this section, correlates with the use of the term *plenum* where the plenum is used for return air purposes, as well as some other air-handling spaces.

Exception: This section shall not apply to the joist or stud spaces of dwelling units where the wiring passes through such spaces perpendicular to the long dimension of such spaces.

Δ (1) Wiring Methods. The wiring methods for other spaces used for environmental air shall be limited to totally enclosed, nonventilated, insulated busway having no provisions for plug-in connections, Type MI cable without an overall nonmetallic covering, Type MC cable without an overall nonmetallic covering, Type AC cable, or other factory-assembled multiconductor control or power cable that is specifically listed for use within an air-handling space, or listed prefabricated cable assemblies of metallic manufactured wiring systems without nonmetallic sheath. Other types of cables, conductors, and raceways shall be permitted to be installed in electrical metallic tubing, flexible metallic tubing, intermediate metal conduit, rigid metal conduit without an overall nonmetallic covering, flexible metal conduit, or, where accessible, surface metal raceway or metal wireway with metal covers.

Nonmetallic cable ties and other nonmetallic cable accessories used to secure and support cables shall be listed as having low smoke and heat release properties.

Informational Note: See UL 2043, *Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces*, for one method of testing low smoke and heat release properties for nonmetallic cable ties and other nonmetallic cable accessories to determine a maximum peak optical density of 0.50 or less, an average optical density of 0.15 or less, and a peak heat release rate of 100 kW or less.

Δ (2) Cable Tray Systems. The requirements in 300.22(C)(2)(a) or (C)(2)(b) shall apply to the use of metallic cable tray systems in other spaces used for environmental air (plenums), where accessible.

(a) *Metal Cable Tray Systems.* Metal cable tray systems shall be permitted to support the wiring methods specified in 300.22(C)(1).

(b) *Solid Side and Bottom Metal Cable Tray Systems.* Solid side and bottom metal cable tray systems with solid metal covers shall be permitted to enclose wiring methods and cables not already covered in 300.22(C)(1) in accordance with 392.10(A) and (B).

Δ (3) Equipment. Electrical equipment with a metal enclosure, or electrical equipment with a nonmetallic enclosure listed for use within an air-handling space and having low smoke and heat release properties, and associated wiring material suitable for the ambient temperature shall be permitted to be installed in such other spaces unless prohibited elsewhere in this Code.

Informational Note: See UL 2043, *Fire Test for Heat and Visible Smoke Release for Discrete Products and Their Accessories Installed in Air-Handling Spaces*, for one method of testing low smoke and heat release properties to determine that the equipment exhibits a maximum peak optical density of 0.50 or less, an average optical density of 0.15 or less, and a peak heat release rate of 100 kW or less.

Exception: Integral fan systems shall be permitted where specifically identified for use within an air-handling space.

(D) Information Technology Equipment. Where the installation complies with the special requirements specified in 645.4, electrical wiring in air-handling areas beneath raised floors for information technology equipment shall be permitted in accordance with 645.5(E).

300.23 Panels Designed to Allow Access. Cables, raceways, and equipment installed behind panels designed to allow access, including suspended ceiling panels, shall be arranged and secured to allow the removal of panels and access to the equipment.

300.25 Exit Enclosures (Stair Towers). Where an exit enclosure is required to have a fire resistance rating, only electrical wiring methods serving equipment permitted by the authority having jurisdiction in the exit enclosure shall be installed within the exit enclosure.

Exception: Where egress lighting is required on outside exterior doorways from the exit enclosure, luminaires shall be permitted to be supplied from the inside of the exit enclosure.

Informational Note: See NFPA 101-2021, Life Safety Code, 7.1.3.2.1(10)(b), for more information.

300.26 Remote-Control and Signaling Circuits Classification. Remote-control and signaling circuits shall be classified as either power-limited or non-power-limited and comply with the following:

- (1) Class 1 power-limited remote-control and signaling circuits shall comply with 724.3.
- (2) Class 2 and Class 3 power-limited remote-control and signaling circuits shall comply with 725.3.
- (3) Non-power-limited remote-control and signaling circuits shall be installed in accordance with 300.2 through 300.25.

ARTICLE 305 General Requirements for Wiring Methods and Materials for Systems Rated Over 1000 Volts ac, 1500 Volts dc, Nominal

305.1 Scope. This article covers wiring methods and materials for systems rated over 1000 volts ac, 1500 volts dc, nominal.

305.3 Other Articles. Conductors shall be permitted to be installed in accordance with any of the wiring methods identified in Table 305.3.

Exposed runs of Type MV cables, bare conductors, and bare busbars shall be permitted in locations accessible only to qualified persons. Busbars shall be permitted to be either copper or aluminum.

Exception: Airfield lighting cable used in series circuits that are powered by regulators and installed in restricted airport lighting vaults shall be permitted as exposed cable installations.

Informational Note: An example of a common application is FAA L-824 cables installed as exposed runs within a restricted vault area.

Table 305.3 Wiring Methods Permitted for Use in Systems Rated Over 1000 Volts ac, 1500 Volts dc, Nominal

Wiring Methods Permitted for Use Above 1000 Volts ac, 1500 Volts dc	Voltage Levels	Reference
Pull and junction boxes, conduit bodies, and handhole enclosures	Over 1000	Article 314, Part IV
Metal-clad cable (Type MC)	1000–35,000	Article 330
Type P cable	1000–2000	Article 337
Intermediate metal conduit (IMC)	Over 1000	Article 342
Rigid metal conduit (RMC)	Over 1000	Article 344
Rigid polyvinyl chloride conduit (PVC)	Over 1000	Article 352
Reinforced thermosetting resin conduit (RTRC)	Over 1000	Article 355
Electrical metallic tubing (EMT)	Over 1000	Article 358
Auxiliary gutters	Over 1000	Article 366
Busway	Over 1000	Article 368, Part IV
Cablebus	1000–35,000	Article 370
Cable trays	1000–35,000	Article 392
Messenger-supported wiring	1000–35,000	Article 396
Outdoor overhead conductors	Over 1000	Article 395
Insulated bus pipe (IBP)	1000–35,000 ac	Article 369

305.4 Conductors of Different Systems. Conductors of circuits rated over 1000 volts ac, 1500 volts dc, nominal, shall not occupy the same equipment wiring enclosure, cable, or raceway with conductors of circuits rated 1000 volts ac, 1500 volts dc, nominal, or less unless otherwise permitted as follows:

- (1) Where contained within the individual wiring enclosure, primary leads of electric-discharge lamp ballasts insulated for the primary voltage of the ballast shall be permitted to occupy the same luminaire, sign, or outline lighting enclosure as the branch-circuit conductors.
- (2) Excitation, control, relay, and ammeter conductors used in connection with any individual motor or starter shall be permitted to occupy the same enclosure as the motor-circuit conductors.
- (3) Conductors of different voltage ratings shall be permitted in motors, transformers, switchgear, switchboards, control assemblies, and similar equipment.
- (4) If the conductors of each system in a manhole are permanently and effectively separated from the conductors of the other systems and securely fastened to racks, insulators, or other approved supports, conductors of different voltage ratings shall be permitted.

Conductors having nonshielded insulation and operating at different voltage levels shall not occupy the same enclosure, cable, or raceway.

305.5 Conductor Bending Radius. The conductor shall not be bent to a radius less than 8 times the overall diameter for nonshielded conductors or 12 times the overall diameter for shielded or lead-covered conductors during or after installation. For multiconductor or multiplexed single-conductor

cables having individually shielded conductors, the minimum bending radius shall be 12 times the diameter of the individually shielded conductors or 7 times the overall diameter, whichever is greater.

Δ **305.6 Protection Against Induction Heating.** Metallic raceways and associated conductors shall be arranged to avoid heating of the raceway in accordance with 300.20.

• **305.7 Covers Required.** Suitable covers shall be installed on all boxes, fittings, and similar enclosures to prevent accidental contact with energized parts or physical damage to parts or insulation.

• **305.8 Raceways in Wet Locations Above Grade.** Where raceways are installed in wet locations above grade, the interior of these raceways shall be considered to be a wet location. Insulated conductors and cables installed in raceways in wet locations above grade shall be either moisture-impervious metal-sheathed or of a type listed for use in wet locations.

305.9 Braid-Covered Insulated Conductors — Exposed Installation. Exposed runs of braid-covered insulated conductors shall have a flame-retardant braid. If the conductors used do not have this protection, a flame-retardant saturant shall be applied to the braid covering after installation. This treated braid covering shall be stripped back a safe distance at conductor terminals, according to the operating voltage. Where practicable, this distance shall not be less than 25 mm (1 in.) for each kilovolt of the conductor-to-ground voltage of the circuit.

305.10 Insulation Shielding. Metallic and semiconducting insulation shielding components of shielded cables shall be removed for a distance dependent on the circuit voltage and insulation. Stress reduction means shall be provided at all terminations of factory-applied shielding.

Metallic shielding components such as tapes, wires, or braids, or combinations of them, shall be connected to an equipment grounding conductor, an equipment grounding busbar, or a grounding electrode.

305.11 Moisture or Mechanical Protection for Metal-Sheathed Cables. Where cable conductors emerge from a metal sheath and where protection against moisture or physical damage is necessary, the insulation of the conductors shall be protected by a cable sheath terminating device.

305.12 Danger Signs. Danger signs shall be conspicuously posted at points of access to conductors in all raceway systems and cable systems. The sign(s) shall meet the requirements in 110.21(B), shall be readily visible, and shall state the following:

DANGER—HIGH VOLTAGE—KEEP OUT

305.15 Underground Installations.

(A) **General.** Underground conductors shall be identified for the voltage and conditions under which they are installed. Conductors used for direct-burial applications shall be of a type identified for such use. Underground cables shall be installed in accordance with 305.15(A)(1), (A)(2), or (A)(3), and the installation shall meet the depth requirements of Table 305.15(A).

Δ (1) **Shielded Cables and Nonshielded Cables in Metal-Sheathed Cable Assemblies.** Underground cables, including nonshielded, Type MC and moisture-impervious metal sheath cables, shall have those sheaths grounded through an effective

grounding path meeting the requirements of 250.4(A)(5) or 250.4(B)(4). They shall be direct buried or installed in raceways identified for the use.

(2) **Industrial Establishments.** In industrial establishments, where conditions of maintenance and supervision ensure that only qualified persons service the installed cable, nonshielded single-conductor cables with insulation types up to 2000 volts that are listed for direct burial shall be permitted to be directly buried.

(3) **Other Nonshielded Cables.** Other nonshielded cables not covered in 305.15(A)(1) or (A)(2) shall be installed in rigid metal conduit, intermediate metal conduit, or rigid nonmetallic conduit encased in not less than 75 mm (3 in.) of concrete.

(B) **Wet Locations.** The interior of enclosures or raceways installed underground shall be considered to be a wet location. Insulated conductors and cables installed in these enclosures or raceways in underground installations shall be listed for use in wet locations and shall be either moisture-impervious metal-sheathed or of a type listed for use in wet locations. Any connections or splices in an underground installation shall be approved for wet locations.

(C) **Protection from Damage.** Conductors emerging from the ground shall be enclosed in listed raceways. Raceways installed on poles shall be of rigid metal conduit, intermediate metal conduit, RTRC-XW, Schedule 80 PVC conduit, or equivalent, extending from the minimum cover depth specified in Table 305.15(A) to a point 2.5 m (8 ft) above finished grade. Conductors entering a building shall be protected by an approved enclosure or raceway from the minimum cover depth to the point of entrance. Where direct-buried conductors, raceways, or cables are subject to movement by settlement or frost, they shall be installed to prevent damage to the enclosed conductors or to the equipment connected to the raceways. Metallic enclosures shall be grounded.

(D) **Splices.** Direct burial cables shall be permitted to be spliced or tapped without the use of splice boxes if they are installed using materials suitable for the application. The taps and splices shall be watertight and protected from mechanical damage. Where cables are shielded, the shielding shall be continuous across the splice or tap.

Exception: At splices of an engineered cabling system, metallic shields of direct-buried single-conductor cables with maintained spacing between phases shall be permitted to be interrupted and overlapped. Where shields are interrupted and overlapped, each shield section shall be grounded at one point.

(E) **Backfill.** Backfill containing large rocks, paving materials, cinders, large or sharply angular substances, or corrosive materials shall not be placed in an excavation where materials can damage or contribute to the corrosion of raceways, cables, or other substructures or where it might prevent adequate compaction of fill.

Protection in the form of granular or selected material or suitable sleeves shall be provided to prevent physical damage to the raceway or cable.

Δ (F) **Raceway Seal.** Where a raceway enters from an underground system, the end within the building shall be sealed with an identified compound to prevent the entrance of moisture.

Informational Note: Presence of hazardous gases or vapors might also necessitate sealing of underground conduits or raceways entering buildings.

ARTICLE 310 Conductors for General Wiring

Part I. General

Δ 310.1 Scope. This article covers general requirements for conductors rated up to and including 2000 volts and their type designations, insulations, markings, mechanical strengths, ampacity ratings, and uses. These requirements do not apply to conductors that form an integral part of equipment, such as motors, motor controllers, and similar equipment, or to conductors specifically provided for elsewhere in this *Code*.

310.3 Conductors.

(A) Minimum Size of Conductors. The minimum size of conductors for voltage ratings up to and including 2000 volts shall be 14 AWG copper or 12 AWG aluminum or copper-clad aluminum, except as permitted elsewhere in this *Code*.

Δ (B) Conductor Material. Conductors in this article shall be of copper, aluminum, or copper-clad aluminum, unless otherwise

specified. Aluminum and copper-clad aluminum shall comply with the following:

- (1) Solid aluminum conductors 8, 10, and 12 AWG shall be made of an AA-8000 series electrical grade aluminum alloy conductor material.
- (2) Stranded aluminum conductors 8 AWG through 1000 kcmil marked as Type RHH, RHW, XHHW, XHHN, XHWN, THW, THHW, THWN, THHN, service-entrance Type SE Style U, and SE Style R shall be made of an AA-8000 series electrical grade aluminum alloy conductor material.
- (3) For copper-clad aluminum conductors, the copper shall form a minimum 10 percent of the cross-sectional area of a solid conductor or each strand of a stranded conductor. The aluminum core of a copper-clad aluminum conductor shall be made of an AA-8000 series electrical grade aluminum alloy conductor material.
- (4) Copper-clad aluminum conductor material shall be listed.

(C) Stranded Conductors. Where installed in raceways, conductors 8 AWG and larger shall be stranded, unless specifically permitted or required elsewhere in this *Code* to be solid.

(D) Insulated. Conductors not specifically permitted elsewhere in this *Code* to be covered or bare shall be insulated.

Informational Note: See 250.184 for insulation of neutral conductors of a solidly grounded high-voltage system.

Δ Table 305.15(A) Minimum Cover Requirements

Circuit Voltage	General Conditions (not otherwise specified)						Special Conditions (use if applicable)					
	Column 1		Column 2		Column 3		Column 4		Column 5		Column 6	
	Direct-Buried Cables ¹		Electrical Metallic Tubing, RTRC, PVC, and HDPE Conduit ²		Rigid Metal Conduit and Intermediate Metal Conduit		Raceways Under Buildings or Exterior Concrete Slabs, 100 mm (4 in.) Minimum Thickness ³		Cables in Airport Runways or Adjacent Areas Where Trespass Is Prohibited		Areas Subject to Vehicular Traffic, Such as Thoroughfares and Commercial Parking Areas	
	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
Over 1000 V ac, 1500 V dc, through 22 kV	750	30	450	18	150	6	100	4	450	18	600	24
Over 22 kV through 40 kV	900	36	600	24	150	6	100	4	450	18	600	24
Over 40 kV	1000	42	750	30	150	6	100	4	450	18	600	24

Notes:

1. Cover shall be defined as the shortest distance in millimeters (inches) measured between a point on the top surface of any direct-buried conductor, cable, conduit, or other raceway and the top surface of finished grade, concrete, or similar cover.

2. Lesser depths shall be permitted where cables and conductors rise for terminations or splices or where access is otherwise required.

3. Where solid rock prevents compliance with the cover depths specified in this table, the wiring shall be installed in a metal or nonmetallic raceway permitted for direct burial. The raceways shall be covered by a minimum of 50 mm (2 in.) of concrete extending down to rock.

4. In industrial establishments, where conditions of maintenance and supervision ensure that qualified persons will service the installation, the minimum cover requirements for other than rigid metal conduit and intermediate metal conduit shall be permitted to be reduced 150 mm (6 in.) for each 50 mm (2 in.) of concrete or equivalent placed entirely within the trench over the underground installation.

¹Underground direct-buried cables that are not encased or protected by concrete and are buried 750 mm (30 in.) or more below grade shall have their location identified by a warning ribbon that is placed in the trench at least 300 mm (12 in.) above the cables.

²Listed by a qualified testing agency as suitable for direct burial without encasement. All other nonmetallic systems shall require 50 mm (2 in.) of concrete or equivalent above conduit in addition to the table depth.

³The slab shall extend a minimum of 150 mm (6 in.) beyond the underground installation, and a warning ribbon or other effective means suitable for the conditions shall be placed above the underground installation.

Part II. Construction Specifications

310.4 Conductor Constructions and Applications. Insulated conductors shall comply with Table 310.4(1) and Table 310.4(2).

Informational Note: Thermoplastic insulation may stiffen at temperatures lower than -10°C ($+14^{\circ}\text{F}$). Thermoplastic insulation may also be deformed at normal temperatures where subjected to pressure, such as at points of support.

310.6 Conductor Identification.

(A) Grounded Conductors. Insulated or covered grounded conductors shall be identified in accordance with 200.6.

(B) Equipment Grounding Conductors. Equipment grounding conductors shall be identified in accordance with 250.119.

Δ (C) Ungrounded Conductors. Conductors that are intended for use as ungrounded conductors, whether used as a single conductor or in multiconductor cables, shall be finished to be clearly distinguishable from grounded conductors and equipment grounding conductors. Distinguishing markings shall not conflict in any manner with the surface markings required by 310.8(B)(1). Branch-circuit ungrounded conductors shall be identified in accordance with 210.5(C). Feeders shall be identified in accordance with 215.12(C).

Exception: Conductor identification shall be permitted in accordance with 200.7.

310.8 Marking.

(A) Required Information. All conductors and cables shall be marked to indicate the following information, using the applicable method described in 310.8(B):

- (1) The maximum rated voltage.
- (2) The proper type letter or letters for the type of wire or cable as specified elsewhere in this Code.
- (3) The manufacturer's name, trademark, or other distinctive marking by which the organization responsible for the product can be readily identified.
- (4) The AWG size or circular mil area.

Informational Note: See Chapter 9, Table 8, Conductor Properties, for conductor area expressed in SI units for conductor sizes specified in AWG or circular mil area.

- (5) Cable assemblies where the neutral conductor is smaller than the ungrounded conductors shall be so marked.

(B) Method of Marking.

(1) Surface Marking. The following conductors and cables shall be durably marked on the surface:

- (1) Single-conductor and multiconductor thermoset and thermoplastic-insulated wire and cable
- (2) Nonmetallic-sheathed cable
- (3) Service-entrance cable
- (4) Underground feeder and branch-circuit cable
- (5) Tray cable
- (6) Irrigation cable
- (7) Power-limited tray cable
- (8) Instrumentation tray cable

The AWG size or circular mil area shall be repeated at intervals not exceeding 610 mm (24 in.). All other markings shall be repeated at intervals not exceeding 1.0 m (40 in.).

Δ (2) Marker Tape. Metal-covered multiconductor cables shall employ a marker tape located within the cable and running for its complete length.

Exception No. 1: Type MI cable shall not require a marker tape.

Exception No. 2: Type AC cable shall not require a marker tape.

Exception No. 3: The information required in 310.8(A) shall be permitted to be durably marked on the outer nonmetallic covering of Type MC, Type ITC, or Type PLTC cables at intervals not exceeding 1.0 m (40 in.).

Exception No. 4: The information required in 310.8(A) shall be permitted to be durably marked on a nonmetallic covering under the metallic sheath of Type ITC or Type PLTC cable at intervals not exceeding 1.0 m (40 in.).

Informational Note: Included in the group of metal-covered cables are Type AC cable, Type MC cable, and lead-sheathed cable.

(3) Tag Marking. The following conductors and cables shall be marked by means of a printed tag attached to the coil, reel, or carton:

- (1) Type MI cable
- (2) Switchboard wires
- (3) Metal-covered, single-conductor cables
- (4) Type AC cable

(4) Optional Marking of Wire Size. The information required in 310.8(A)(4) shall be permitted to be marked on the surface of the individual insulated conductors for the following multiconductor cables:

- (1) Type MC cable
- (2) Tray cable
- (3) Irrigation cable
- (4) Power-limited tray cable
- (5) Power-limited fire alarm cable
- (6) Instrumentation tray cable

(C) Suffixes to Designate Number of Conductors. A type letter or letters used alone shall indicate a single insulated conductor. The letter suffixes shall be indicated as follows:

- (1) D — For two insulated conductors laid parallel within an outer nonmetallic covering
- (2) M — For an assembly of two or more insulated conductors twisted spirally within an outer nonmetallic covering

(D) Optional Markings. All conductors and cables contained in Chapter 3 shall be permitted to be surface marked to indicate special characteristics of the cable materials. These markings include, but are not limited to, markings for limited smoke, sunlight resistant, and so forth.

Table 310.4(1) Conductor Applications and Insulations Rated 600 Volts

Trade Name	Type Letter	Maximum Operating Temperature	Application Provisions	Insulation	Thickness of Insulation				Outer Covering ¹		
					AWG or kcmil	mm	mils				
Fluorinated ethylene propylene	FEP or FEPB	90°C (194°F)	Dry and damp locations	Fluorinated ethylene propylene	14–10 8–2	0.51 0.76	20 30		None		
		200°C (392°F)	Dry locations — special applications ²	Fluorinated ethylene propylene	14–8	0.36	14		Glass braid		
					6–2	0.36	14		Glass or other suitable braid material		
Mineral insulation (metal sheathed)	MI	90°C (194°F)	Dry and wet locations	Magnesium oxide	18–16 ³ 16–10	0.58 0.91	23 36		Copper or alloy steel		
		250°C (482°F)	For special applications ²		9–4 3–500	1.27 1.40	50 55				
Moisture-, heat-, and oil-resistant thermoplastic	MTW	60°C (140°F) 90°C (194°F)	Machine tool wiring in wet locations	Flame-retardant, moisture-, heat-, and oil-resistant thermoplastic	22–12 10 8 6 4–2 1–4/0 213–500 501–1000	(A)	(B)	(A)	(B)	(A) None (B) Nylon jacket or equivalent	
						Machine tool wiring in dry locations.	0.76	0.38	30		15
			0.76				0.51	30	20		
			1.14				0.76	45	30		
			1.52				0.76	60	30		
			1.52				1.02	60	40		
			2.03				1.27	80	50		
			2.41				1.52	95	60		
			2.79				1.78	110	70		
			Paper				85°C (185°F)	For underground service conductors, or by special permission	Paper		
Perfluoro-alkoxy	PFA	90°C (194°F) 200°C (392°F)	Dry and damp locations	Perfluoro-alkoxy	14–10 8–2 1–4/0	0.51 0.76 1.14	20 30 45		None		
			Dry locations — special applications ²								
Perfluoro-alkoxy	PFAH	250°C (482°F)	Dry locations only. Only for leads within apparatus or within raceways connected to apparatus (nickel or nickel-coated copper only)	Perfluoro-alkoxy	14–10 8–2 1–4/0	0.51 0.76 1.14	20 30 45		None		
Thermoset	RHH	90°C (194°F)	Dry and damp locations		14–10 8–2 1–4/0 213–500 501–1000 1001–2000	1.14 1.52 2.03 2.41 2.79 3.18	45 60 80 95 110 125		Moisture-resistant, flame-retardant, nonmetallic covering ¹		
Moisture-resistant thermoset	RHW	75°C (167°F)	Dry and wet locations	Flame-retardant, moisture-resistant thermoset	14–10 8–2 1–4/0 213–500 501–1000 1001–2000	1.14 1.52 2.03 2.41 2.79 3.18	45 60 80 95 110 125		Moisture-resistant, flame-retardant, nonmetallic covering		
	RHW-2	90°C (194°F)									
Silicone	SA	90°C (194°F)	Dry and damp locations	Silicone rubber	14–10 8–2 1–4/0 213–500 501–1000 1001–2000	1.14 1.52 2.03 2.41 2.79 3.18	45 60 80 95 110 125		Glass or other suitable braid material		
		200°C (392°F)	For special application ²								

(continues)