# NFPA 70A Electrical Code for One- and Two-Family Dwellings 1990 Edition

Excerpted from the 1990 National Electrical Code®

NFPA®
National Fire Protection Association
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The Board of Directors reaffirms that the National Fire Protection Association recognizes that the toxicity of the products of combustion is an important factor in the loss of life from fire. NFPA has dealt with that subject in its technical committee documents for many years.

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**NFPA 70A**

# Electrical Code for One- and Two-Family Dwellings

**1990 Edition**

**Excerpted from the 1990 *National Electrical Code*® NFPA 70 - 1990**

## Explanation of this Code

This Electrical Code for One- and Two-Family Dwellings (NFPA 70A-1990) covers those wiring methods and materials most commonly encountered in the construction of new one- and two-family dwellings. Other wiring methods, materials and subject matter covered in the 1990 *National Electrical Code* (NFPA 70-1990) are also recognized by this Code. (See preface for further information.)

The development of this Code was first undertaken in 1968 to meet the expressed need for an electrical code applicable only to dwellings as a convenience to those whose interests are so oriented. With the approval of the Correlating Committee of the National Electrical Code Committee, an Ad Hoc Committee was established of those primarily concerned to guide this project to completion. Those asked to serve on the Ad Hoc Committee included representatives of the following organizations: American Insurance Association, Building Officials and Code Administrators International, Inc., Department of Housing and Urban Development, Edison Electric Institute, International Association of Electrical Inspectors, International Brotherhood of Electrical Workers, International Conference of Building Officials, National Association of Home Builders, the National Electrical Contractors Association, and Underwriters Laboratories Inc.

It was decided that the Electrical Code for One- and Two-Family Dwellings should consist of excerpts from the complete current *National Electrical Code* without any modification of intent and with minimum editorial change. Article and section numbers have been retained to permit close correlation.

Following decisions made by the Correlating Committee and by the Technical Subcommittee on format and content, the excerpted and editorially revised material was formally submitted to members of the Technical Subcommittee and the Correlating Committee for letter ballot, to determine if the editorial changes had been achieved without altering the intent of the complete Code.

# Technical Subcommittee for Electrical Code for One- and Two-Family Dwellings

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# Electrical Code for One- and Two-Family Dwellings

**Excerpted from the 1990 *National Electrical Code*, NFPA 70A-1990**
*(For rules covering wiring methods and equipment not included here, see the 1990 National Electrical Code.)*

## PREFACE

This Code has been prepared under the guidance of a Technical Subcommittee (see page 70A-ii) for preparation of an Electrical Code for One- and Two-Family Dwellings, as authorized by the National Electrical Code Committee through its Correlating Committee.

Only those wiring methods and materials most commonly encountered in construction of new 1- and 2-family dwellings are included in this Code. Other wiring methods, materials, and subject matter covered in the 1990 *National Electrical Code* (NFPA 70-1990) are also recognized by this Code.

In like manner, only current ratings up to and including 225 amperes and voltages up to and including 600 volts are included in this Code. It is the intent that the rules covering any wiring methods, any materials, or any type of equipment, such as motors, not specifically included in this Code are to be covered by the applicable rules in the 1990 *National Electrical Code*.

Where a reference is made to an article or section not included in this Code, such as to Article 430 or to Section 430-52, the reference is to that article or section appearing in the *National Electrical Code*.

The rules in this Code have been excerpted from the 1990 *National Electrical Code*, but editorially revised where necessary to restrict their applicability to 1- and 2-family dwellings.

The section numbers assigned to these rules are the same as in the 1990 *National Electrical Code*. However, there are many paragraphs in the 1990 *National Electrical Code* that do not appear in this Code. Consequently, there are instances where gaps appear in the normal sequence of section numbers and alphabetical paragraph designations.

This Code has been formulated for the convenience of inspectors, contractors, builders, and others who are primarily interested in only those NEC® rules which apply to 1- and 2-family dwellings. A revised edition will be issued following each revised edition of the *National Electrical Code* to ensure that there is no divergence between the requirements of the Codes as they pertain to 1- and 2-family dwellings.

NFPA 70A

# Electrical Code for One- and Two-Family Dwellings

1990 Edition

## ARTICLE 90 — INTRODUCTION

### 90-1. Purpose.

**(a) Practical Safeguarding.** The purpose of this Code is the practical safeguarding of persons and property from hazards arising from the use of electricity.

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

(FPN): 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 will provide for future increases in the use of electricity.

**(c) Intention.** This Code is not intended as a design specification nor an instruction manual for untrained persons.

### 90-2. Scope.

**(a) Covered.** This Code covers:

Only those wiring methods and materials most commonly encountered in construction of new 1- and 2-family dwellings* are included in this Code. Other wiring methods, materials, and subject matter covered in the 1990 *National Electrical Code* (NFPA 70-1990) are also recognized by this Code.

*As used in this Code, 1- and 2-family dwellings do not include mobile homes, recreational vehicles, floating dwelling units, buildings containing more than two dwelling units, or buildings used for other than dwelling purposes.

**(b) Not Covered.** This Code does not cover:

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

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

**(c) Special Permission.** The authority having jurisdiction for enforcing this Code may grant exception for the installation of conductors and equipment, not under the exclusive control of the electric utilities and used to connect the electric utility supply system to the service-entrance conductors of the premises served, provided such installations are outside a building or terminate immediately inside a building wall.

**90-4. Enforcement.** This Code is intended to be suitable for mandatory application by governmental bodies exercising legal jurisdiction over electrical installations and for use by insurance inspectors. The authority having jurisdiction of enforcement of the Code will have the responsibility for making interpretations of the rules, for deciding upon the approval of equipment and materials, and for granting the special permission contemplated in a number of the rules.

The authority having jurisdiction may waive specific requirements in this Code or permit alternate methods, where it is assured that equivalent objectives can be achieved by establishing and maintaining effective safety.

This Code may require new products, constructions, or materials which 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 which comply with the most recent previous edition of this Code adopted by the jurisdiction.

**90-5. Formal Interpretations.** To promote uniformity of interpretation and application of the provisions of this Code, Formal Interpretation procedures have been established.

(FPN): These procedures may be found in the "NFPA Regulations Governing Committee Projects."

**90-6. Examination of Equipment for Safety.** For specific items of equipment and materials referred to in this Code, examinations for safety made under standard conditions will 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 as to 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 which is recognized as having the facilities described above and which requires suitability for installation in accordance with this Code.

(FPN No. 1): See Examination of Equipment, Section 110-3.

(FPN No. 2): See definition of "Listed," Article 100.

**90-8. Metric Units of Measurement.** 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).

Values of measurement in the Code text will be followed by an approximate equivalent value in SI units. Tables will have a footnote for SI conversion units used in the table.

Conduit size, wire size, horsepower designation for motors, and trade sizes that do not reflect actual measurements, e.g., box sizes, will not be assigned dual designation SI units.

(FPN): For metric conversion practices, see Standard for Metric Practice, ANSI/ASTM E380-1984.

## ARTICLE 100 — DEFINITIONS

**Scope.** This article contains only those definitions essential to the proper application of this Code. It is not intended to include commonly defined general terms or commonly defined technical terms from related codes and standards. In general, only those terms used in two or more articles are defined in Article 100. Other definitions are included in the article in which they are used but may be referenced in Article 100.

**AC General-Use Snap Switch:** See under "Switches."

**AC-DC General-Use Snap Switch:** See under "Switches."

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

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

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

**Ampacity:** The current in amperes a conductor can carry continuously under the conditions of use without exceeding its temperature rating.

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

**Appliance Branch Circuit:** See "Branch Circuit, Appliance."

**Approved:** Acceptable to the authority having jurisdiction.

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

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

**Bare Conductor:** See under "Conductor."

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

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

**Bonding Jumper, Circuit:** The connection between portions of a conductor in a circuit to maintain required ampacity of the circuit.

**Bonding Jumper, Equipment:** The connection between two or more portions of the equipment grounding conductor.

**Bonding Jumper, Main:** The connection between the grounded circuit conductor and the equipment grounding conductor at the service.

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

(FPN): See Section 240-9 and Section 240-10 in the NEC for thermal relays, supplementary overcurrent protection, and other devices.

**Branch Circuit, Appliance:** A branch circuit supplying energy to one or more outlets to which appliances are to be connected; such circuits to have no permanently connected lighting fixtures not a part of an appliance.

**Branch Circuit, General Purpose:** A branch circuit that supplies a number of outlets for lighting and appliances.

**Branch Circuit, Individual:** A branch circuit that supplies only one utilization equipment.

**Branch Circuit, Multiwire:** A branch circuit consisting of two or more ungrounded conductors having a potential difference between them, and a grounded conductor having equal potential difference between it and each ungrounded conductor of the circuit and which is connected to the neutral (grounded) conductor of the system.

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

**Cabinet:** An enclosure designed either for surface or flush mounting and provided with a frame, mat, or trim in which a swinging door or doors are or may be hung.

**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.

(FPN): The automatic opening means can be integral, direct acting with the circuit breaker or remote from the circuit breaker. See definition of "Switching Devices" in Part B of this article for definition applying to circuits and equipment over 600 volts, nominal.

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

**Conductor:**

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

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

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

**Connector, Pressure (Solderless):** 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.

**Continuous Duty:** See under "Duty."

**Continuous Load:** A load where the maximum current is expected to continue for three hours or more.

**Cooking Unit, Counter-Mounted:** A cooking appliance designed for mounting in or on a counter and consisting of one or more heating elements, internal wiring, and built-in or separately mountable controls. (See "Oven, Wall-Mounted.")

**Copper-Clad Aluminum Conductors:** Conductors drawn from a copper-clad aluminum rod with the copper metallurgically bonded to an aluminum core. The copper forms a minimum of 10 percent of the cross-sectional area of a solid conductor or each strand of a stranded conductor.

**Covered Conductor:** See under "Conductor."

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

**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.

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

**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.

**Duty:**

**Continuous Duty:** Operation at a substantially constant load for an indefinitely long time.

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

**Periodic Duty:** Intermittent operation in which the load conditions are regularly recurrent.

**Short-Time Duty:** Operation at a substantially constant load for a short and definitely specified time.

**Varying Duty:** Operation at loads, and for intervals of time, both of which may be subject to wide variation.

(FPN): See Table 430-22(a) Exception in the NEC for illustration of various types of duty.

**Dwelling:**

**Dwelling Unit:** One or more rooms for the use of one or more persons as a housekeeping unit with space for eating, living, and sleeping, and permanent provisions for cooking and sanitation.

**Multifamily Dwelling:** A building containing three or more dwelling units.

**One-Family Dwelling:** A building consisting solely of one dwelling unit.

**Two-Family Dwelling:** A building consisting solely of two dwelling units.

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

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

(FPN): For enclosure types, see Enclosures for Electrical Equipment (1000 Volts Maximum), ANSI/NEMA 250-1985.

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

**Equipment Grounding Conductor:** See "Grounding Conductor, Equipment."

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

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

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

**Feeder:** All circuit conductors between the service equipment or the source of a separately derived system and the final branch-circuit overcurrent device.

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

**General-Purpose Branch Circuit:** See "Branch Circuit, General Purpose."

**General-Use Snap Switch:** See under "Switches."

**General-Use Switch:** See under "Switches."

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

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

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

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

**Grounding Conductor, Equipment:** The conductor used to connect the noncurrent-carrying metal parts of equipment, raceways, and other enclosures to the system grounded conductor and/or the grounding electrode conductor at the service equipment or at the source of a separately derived system.

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

**Ground-Fault Circuit-Interrupter:** A device intended for the protection of personnel that functions to deenergize a circuit or portion thereof within an established period of time when a current to ground exceeds some predetermined value that is less than that required to operate the overcurrent protective device of the supply circuit.

**Guarded:** Covered, shielded, fenced, enclosed, or otherwise protected by means of suitable covers, casings, barriers, rails, screens, mats, or platforms to remove the likelihood of approach or contact by persons or objects to a point of danger.

**Identified:** (As applied to Equipment.) Recognizable as suitable for the specific purpose, function, use, environment, application, etc., where described in a particular Code requirement. (See "Equipment.")

(FPN): Suitability of equipment for a specific purpose, environment, or application may be determined by a qualified testing laboratory, inspection agency, or other organization concerned with product evaluation. Such identification may include labeling or listing: see "Labeled," "Listed," and Section 90-6.

**Individual Branch Circuit:** See "Branch Circuit, Individual."

**Insulated Conductor:** See under "Conductor."

**Intermittent Duty:** See under "Duty."

**Interrupting Rating:** The highest current at rated voltage that a device is intended to interrupt under standard test conditions.

(FPN): Equipment intended to break current at other than fault levels may have its interrupting rating implied in other ratings, such as horsepower or locked rotor current.

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

**Labeled:** Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization 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.

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

**Listed:** Equipment or materials included in a list published by an organization acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of listed equipment or materials, and whose listing states either that the equipment or material meets appropriate standards or has been tested and found suitable for use in a specified manner.

(FPN): 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. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

**Multioutlet Assembly:** A type of surface or flush raceway designed to hold conductors and receptacles, assembled in the field or at the factory.

**Multiwire Branch Circuit:** See "Branch Circuit, Multiwire."

**Neutral Conductor:** See Article 310 Note 10 of Notes to Ampacity Tables 0 to 2000 Volts.

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

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

**Overcurrent:** Any current in excess of the rated current of equipment or the ampacity of a conductor. It may result from overload (see definition), short circuit, or ground fault.

(FPN): A current in excess of rating may be accommodated by certain equipment and conductors for a given set of conditions. Hence the rules for overcurrent protection are specific for particular situations.

**Overload:** Operation of equipment in excess of normal, full-load rating, or of a conductor in excess of rated ampacity which, when it persists for a sufficient length of time, would cause damage or dangerous overheating. A fault, such as a short circuit or ground fault, is not an overload. (See "Overcurrent.")

(FPN): For motor apparatus applications, see Section 430-31 in the NEC.

**Periodic Duty:** See under "Duty."

**Plenum:** A compartment or chamber to which one or more air ducts are connected and which forms part of the air distribution system.

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

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

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

**Raceway:** An enclosed channel designed expressly for holding wires, cables, or busbars, with additional functions as permitted in this Code.

(FPN): Raceways may be of metal or insulating material, and the term includes rigid metal conduit, rigid nonmetallic conduit, intermediate metal conduit, liquidtight flexible conduit, flexible metallic tubing, flexible metal conduit, electrical nonmetallic tubing, electrical metallic tubing, underfloor raceways, cellular concrete floor raceways, cellular metal floor raceways, surface raceways, wireways, and busways.

**Rainproof:** So constructed, protected, or treated as to prevent rain from interfering with the successful operation of the apparatus under specified test conditions.

**Raintight:** So constructed or protected that exposure to a beating rain will not result in the entrance of water under specified test conditions.

**Readily Accessible:** (See "Accessible, Readily.")

**Receptacle:** A receptacle is a contact device installed at the outlet for the connection of a single attachment plug.

(FPN): A single receptacle is a single contact device with no other contact device on the same yoke. A multiple receptacle is a single device containing two or more receptacles.

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

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

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

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

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

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

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

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

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

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

**Service Lateral:** The underground service conductors between the street main, including any risers at a pole or other structure or from transformers, and the first point of connection to the service-entrance conductors in a terminal box or meter or other enclosure with adequate space, inside or outside the building wall. Where there is no terminal box, meter, or other enclosure with adequate space, the point of connection shall be considered to be the point of entrance of the service conductors into the building.

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

**Switches:**

**General-Use Switch:** A switch intended for use in general distribution and branch circuits. It is rated in amperes, and it is capable of interrupting its rated current at its rated voltage.

**General-Use Snap Switch:** A form of general-use switch so constructed that it can be installed in flush device boxes or on outlet box covers, or otherwise used in conjunction with wiring systems recognized by this Code.

**AC General-Use Snap Switch:** See Section 380-14(a) in the NEC.

**AC-DC General-Use Snap Switch:** See Section 380-14(b) in the NEC.

**Isolating Switch:** A switch intended for isolating an electric circuit from the source of power. It has no interrupting rating, and it is intended to be operated only after the circuit has been opened by some other means.

**Motor-Circuit Switch:** A switch, rated in horsepower, capable of interrupting the maximum operating overload current of a motor of the same horsepower rating as the switch at the rated voltage.

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

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

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

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

**Voltage, Nominal:** A nominal value assigned to a circuit or system for the purpose of conveniently designating its voltage class (as 120/240, 480Y/277, 600, etc.).

The actual voltage at which a circuit operates can vary from the nominal within a range that permits satisfactory operation of equipment.

(FPN): See Voltage Ratings for Electric Power Systems and Equipment (60 Hz), ANSI C84.1-1982.

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

**Watertight:** So constructed that moisture will not enter the enclosure under specified test conditions.

(FPN): For test conditions other than for rotating equipment, see Enclosure for Electrical Equipment (1000 Volts Maximum), Section 250-5.07, Hosedown Test, NEMA Standards Publication No. 250-1979.

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

(FPN): 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.

## ARTICLE 110 — REQUIREMENTS FOR ELECTRICAL INSTALLATIONS

### A. General

**110-1. Mandatory Rules and Explanatory Material.** Mandatory rules of this Code are characterized by the use of the word "shall." Explanatory material is in the form of Fine Print Notes (FPN).

**110-2. Approval.** The conductors and equipment required or permitted by this Code shall be acceptable only if approved.

(FPN): See Examination of Equipment for Safety, Section 90-6 and Examination, Identification, Installation, and Use of Equipment, Section 110-3. See definitions of "Approved," "Identified," "Labeled," and "Listed."

**110-3. Examination, Identification, Installation, and Use of Equipment.**

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

(1) Suitability for installation and use in conformity with the provisions of this Code. 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. 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, specific use.

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

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

**110-4. Voltages.** Throughout this Code the voltage considered shall be that at which the circuit operates.

**110-5. Conductors.** Conductors normally used to carry current shall be of copper unless otherwise provided in this Code. Where the conductor material is not specified, the sizes given in this Code shall apply to copper conductors. Where other materials are used, the size shall be changed accordingly.

(FPN): For aluminum and copper-clad aluminum conductors, see Table 310-16.

**110-6. Conductor Sizes.** Conductor sizes are expressed in American Wire Gage (AWG) or in circular mils.

**110-7. Insulation Integrity.** All wiring shall be so installed that when completed the system will be free from short circuits and from grounds other than as permitted in Article 250.

**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 or occupancy, except as otherwise provided in this Code.

**110-9. Interrupting Rating.** Equipment intended to break current at fault levels shall have an interrupting rating sufficient for the system voltage and the current which is available at the line terminals of the equipment.

Equipment intended to break current at other than fault levels shall have an interrupting rating at system voltage sufficient for the current that must be interrupted.

**110-10. Circuit Impedance and Other Characteristics.** The overcurrent protective devices, the total impedance, the component short-circuit withstand ratings, and other characteristics of the circuit to be protected shall

be so selected and coordinated as to permit the circuit protective devices used to clear a fault without the occurrence of extensive damage to the electrical components of the circuit. This fault shall be assumed to be either between two or more of the circuit conductors, or between any circuit conductor and the grounding conductor or enclosing metal raceway.

**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 having a deteriorating effect on the conductors or equipment; nor where exposed to excessive temperatures.

(FPN): See Section 300-6 for protection against corrosion.

Control equipment, utilization equipment, and busways approved for use in dry locations only shall be protected against permanent damage from the weather during building construction.

**110-12. Mechanical Execution of Work.** Electric equipment shall be installed in a neat and workmanlike manner.

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

**110-13. Mounting and Cooling of Equipment.**

**(a) Mounting.** Electric 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 which depends upon the natural circulation of air and convection principles for cooling of exposed surfaces shall be installed so that room air flow 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.

**110-14. Electrical Connections.** Because of different characteristics of copper and aluminum, 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 (such as copper and aluminum, copper and copper-clad aluminum, or aluminum and copper-clad aluminum), unless the device is identified for the purpose and conditions of use. Materials such as solder, fluxes, inhibitors, and compounds, where employed, shall be suitable for the use and shall be of a type which will not adversely affect the conductors, installation, or equipment.

(FPN): Many terminations and equipment are marked with a tightening torque.

**(a) Terminals.** Connection of conductors to terminal parts shall ensure a thoroughly good connection without damaging the conductors and shall be made by means of pressure connectors (including set-screw type), solder lugs, or splices to flexible leads.

*Exception: Connection by means of wire binding screws or studs and nuts having upturned lugs or equivalent shall be permitted for No. 10 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 suitable for the use or by brazing, welding, or soldering with a fusible metal or alloy. Soldered splices shall first be so spliced or joined as to be mechanically and electrically secure without solder and then soldered. All splices and joints and the free ends of conductors shall be covered with an insulation equivalent to that of the conductors or with an insulating device suitable for the purpose.

**110-16. Working Space About Electric Equipment (600 Volts, Nominal, or Less).** Sufficient access and working space shall be provided and maintained about all electric equipment to permit ready and safe operation and maintenance of such equipment.

**(a) Working Clearances.** Except as elsewhere required or permitted in this Code, the dimension of the working space in the direction of access to live parts operating at 600 volts, nominal, or less to ground and likely to require examination, adjustment, servicing, or maintenance while energized shall not be less than indicated in Table 110-16(a). Distances shall be measured from the live parts if such are exposed or from the enclosure front or opening if such are enclosed. Concrete, brick, or tile walls shall be considered as grounded.

In addition to the dimensions shown in Table 110-16(a), the work space shall not be less than 30 inches (762 mm) wide in front of the electric equipment. In all cases the work space shall permit at least a 90-degree opening of equipment doors or hinged panels.

**Table 110-16(a). Working Clearances**

| Voltage to Ground, Nominal | Minimum Clear Distance (feet) | | |
|---|---|---|---|
| Condition: | 1 | 2 | 3 |
| 0-150 | 3 | 3 | 3 |
| 151-600 | 3 | 3½ | 4 |

For SI units, one inch = 25.4 millimeters; one foot = 0.3048 meter.

**Where the "Conditions" are as follows:**

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

**2.** Exposed live parts on one side and grounded parts on the other side.

**3.** Exposed live parts on both sides of the work space (not guarded as provided in Condition 1) with the operator between.

*Exception No. 1: Working space shall not be required in back of assemblies such as dead-front switchboards, or motor control centers where there are no renewable or adjustable parts such as fuses or switches on the back and where all connections are accessible from locations other than the back.*

*Exception No. 2: By special permission smaller spaces may be permitted (1) where it is judged that the particular arrangement of the installation will provide adequate accessibility, or (2) where all uninsulated parts are at a voltage no greater than 30 volts RMS or 42 volts dc.*

**(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) Access and Entrance to Working Space.** At least one entrance of sufficient area shall be provided to give access to the working space about electric equipment.

**110-17. Guarding of Live Parts (600 Volts, Nominal, or Less).**

**(a) Live Parts Guarded Against Accidental Contact.** Except as elsewhere required or permitted by this Code, live parts of electric equipment operating at 50 volts or more shall be guarded against accidental contact by approved enclosures.

**110-18. Arcing Parts.** Parts of electric equipment which in ordinary operation produce arcs, sparks, flames, or molten metal shall be enclosed or separated and isolated from all combustible material.

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

**110-22. Identification of Disconnecting Means.** Each disconnecting means required by this Code for motors and appliances, and each service, feeder, or branch circuit at the point where it originates shall be legibly marked to indicate its purpose unless located and arranged so the purpose is evident. The marking shall be of sufficient durability to withstand the environment involved.

## ARTICLE 200 — USE AND IDENTIFICATION OF GROUNDED CONDUCTORS

**200-1. Scope.** This article provides requirements for: (1) identification of terminals; (2) grounded conductors in premises wiring systems; and (3) identification of grounded conductors.

(FPN): See Article 100 for definitions of "Grounded Conductor" and "Grounding Conductor."

**200-2. General.** All premises wiring systems shall have a grounded conductor that is identified in accordance with Section 200-6.

*Exception: Circuits and systems exempted or prohibited by Sections 210-10, 215-7, and 250-5.*

The grounded conductor, when insulated, shall have insulation which is suitable, other than color, for any ungrounded conductor of the same circuit on circuits of less than 1000 volts.

**200-3. Connection to Grounded System.** Premises wiring shall not be electrically connected to a supply system unless the latter contains, for any grounded conductor of the interior system, a corresponding conductor which is grounded.

For the purpose of this section, "electrically connected" shall mean connected so as to be capable of carrying current as distinguished from connection through electromagnetic induction.

**200-6. Means of Identifying Grounded Conductors.**

**(a) Sizes No. 6 or Smaller.** An insulated grounded conductor of No. 6 or smaller shall be identified by a continuous white or natural gray outer finish along its entire length.

**(b) Sizes Larger than No. 6.** An insulated grounded conductor larger than No. 6 shall be identified either by a continuous white or natural gray outer finish along its entire length or at the time of installation by a distinctive white marking at its terminations. Multiconductor flat cable No. 4 or larger shall be permitted to employ an external ridge on the grounded conductor.

**(c) Flexible Cords.** An insulated conductor intended for use as a grounded conductor, where contained within a flexible cord, shall be identified by a white or natural gray outer finish or by methods permitted by Section 400-22 in the NEC.

**200-7. Use of White or Natural Gray Color.** A continuous white or natural gray covering on a conductor or a termination marking of white or natural gray color shall be used only for the grounded conductor.

*Exception No. 1: An insulated conductor with a white or natural gray finish shall be permitted as an ungrounded conductor where permanently reidentified to indicate its use, by painting or other effective means at its termination, and at each location where the conductor is visible and accessible.*

*Exception No. 2: A cable containing an insulated conductor with a white or natural gray outer finish shall be permitted for single-pole, 3-way, or 4-way switch loops where the white or natural gray conductor is used for the supply to the switch, but not as a return conductor from the switch to the switched outlet. In these applications, reidentification of the white or natural gray conductor shall not be required.*

*Exception No. 3: A flexible cord, for connecting an appliance, having one conductor identified with a white or natural gray outer finish, or by any other means permitted by Section 400-22 in the NEC, shall be permitted whether or not the outlet to which it is connected is supplied by a circuit having a grounded conductor.*

*Exception No. 4: A white or natural gray conductor of circuits of less than 50 volts shall be required to be grounded only as required by Section 250-5(a).*

**200-9. Means of Identification of Terminals.** The identification of terminals to which a grounded conductor is to be connected shall be substantially white in color. The identification of other terminals shall be of a readily distinguishable different color.

**200-10. Identification of Terminals.**

**(a) Device Terminals.** All devices provided with terminals for the attachment of conductors and intended for connection to more than one side of the circuit shall have terminals properly marked for identification.

*Exception No. 1: Where the electrical connection of a terminal intended to be connected to the grounded conductor is clearly evident.*

*Exception No. 2: The terminals of lighting and appliance branch-circuit panelboards.*

*Exception No. 3: Devices having a normal current rating of over 30 amperes other than polarized attachment plugs and polarized receptacles for attachment plugs as required in (b) below.*

**(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 (white) conductor identified.

Identification shall be by a metal or metal coating substantially white in color or the word "white" located adjacent to the identified terminal.

If the terminal is not visible, the conductor entrance hole for the connection shall be colored white or marked with the word "white."

*Exception: Terminal identification shall not be required for 2-wire nonpolarized attachment plugs.*

(FPN): See Section 250-119 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 natural gray finish. The outer finish of the other conductor shall be of a solid color that will not be confused with the white or natural gray finish used to identify the grounded conductor.

**(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: (1) by permanent wiring methods; or (2) by 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 designated polarity.

# ARTICLE 210 — BRANCH CIRCUITS

## A. General Provisions

**210-1. Scope.** This article covers branch circuits except for branch circuits which supply only motor loads, which are covered in Article 430 in the NEC. Provisions of this article and Article 430 in the NEC apply to branch circuits with combination loads.

**210-2. Other Articles for Specific-Purpose Branch Circuits.** Branch circuits shall comply with this article and also with the applicable provisions of other articles of this Code. The provisions for branch circuits supplying equipment in the following list amend or supplement the provisions in this article and shall apply to branch circuits referred to therein:

| | Article | Section |
|---|---|---|
| Class 1, Class 2, and Class 3 Remote-Control, Signaling, and Power-Limited Circuits | 725 | |
| Fixed Electric Space Heating Equipment | | 424-3 |

**210-3. Classifications.** Branch circuits recognized by this article shall be classified in accordance with the maximum permitted ampere rating or setting of the overcurrent device. The classification for other than individual branch circuits shall be: 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 classification.

**210-4. Multiwire Branch Circuits.**

**(a) General.** Branch circuits recognized by this article shall be permitted as multiwire circuits. A multiwire branch circuit shall be permitted to be considered as multiple circuits. All conductors shall originate from the same panelboard.

**(b) Dwelling Units.** In dwelling units a multiwire branch circuit supplying more than one device or equipment on the same yoke shall be provided with a means to disconnect simultaneously all ungrounded conductors at the panelboard where the branch circuit originated.

**(c) Line to Neutral Load.** Multiwire branch circuits shall supply only line to neutral load.

*Exception No. 1: A multiwire branch circuit that supplies only one utilization equipment.*

*Exception No. 2: Where all ungrounded conductors of the multiwire branch circuit are opened simultaneously by the branch-circuit overcurrent device.*

(FPN): See Section 300-13(b) for continuity of grounded conductor on multiwire circuits.

**210-5. Color Code for Branch Circuits.**

**(a) Grounded Conductor.** The grounded conductor of a branch circuit shall be identified by a continuous white or natural gray color. Where conductors of different systems are installed in the same raceway, box, auxiliary gutter, or other types of enclosures, one system grounded conductor, if

required, shall have an outer covering of white or natural gray. Each other system grounded conductor, if required, shall have an outer covering of white with an identifiable colored stripe (not green) running along the insulation or other and different means of identification.

**(b) Equipment Grounding Conductor.** The equipment grounding conductor of a branch circuit shall be identified by a continuous green color or a continuous green color with one or more yellow stripes unless it is bare.

*Exception No. 1: As permitted in Section 250-57(b), Exceptions No. 1 and 3 and Section 310-12(b), Exceptions No. 1 and 2 in the NEC.*

*Exception No. 2: The use of conductor insulation having a continuous green color or a continuous green color with one or more yellow stripes shall be permitted for internal wiring of equipment if such wiring does not serve as the lead wires for connection to branch-circuit conductors.*

### 210-6. Branch Circuit Voltage Limitations.

**(a) Occupancy Limitation.** In dwelling units the voltage shall not exceed 120 volts, nominal, between conductors that supply the terminals of:

(1) Lighting fixtures;

(2) Cord- and plug-connected loads 1440 volt-amperes, nominal, or less, or less than 1/4 horsepower.

**(b) 120 Volts Between Conductors.** Circuits not exceeding 120 volts, nominal, between conductors shall be permitted to supply:

(1) The terminals of medium-base screw-shell lampholders or lampholders of other types applied within their voltage ratings.

(2) Auxiliary equipment of electric discharge lamps.

(3) Cord- and plug-connected or permanently connected utilization equipment.

### 210-7. Receptacles and Cord Connectors.

**(a) Grounding Type.** Receptacles installed on 15- and 20-ampere branch circuits shall be of the grounding type. Grounding-type receptacles shall be installed only on circuits of the voltage class and current for which they are rated, except as provided in Tables 210-21(b)(2) and (b)(3).

*Exception: Nongrounding-type receptacles installed in accordance with Section 210-7(d), Exception.*

**(b) To Be Grounded.** Receptacles and cord connectors having grounding contacts shall have those contacts effectively grounded.

*Exception No. 2: Ground-fault circuit-interrupter replacement receptacles as permitted by Section 210-7(d), Exception.*

**(c) Methods of Grounding.** The grounding contacts of receptacles and cord connectors shall be grounded by connection to the equipment grounding conductor of the circuit supplying the receptacle or cord connector.

The branch circuit or branch-circuit raceway shall include or provide a grounding conductor to which the grounding contacts of the receptacle or cord connector shall be connected.

(FPN No. 1): Section 250-91(b) describes acceptable grounding means.

(FPN No. 2): For extensions of existing branch circuits, see Section 250-50.

**(d) Replacements.** Grounding-type receptacles shall be used as replacements for existing nongrounding types and shall be connected to a grounding conductor installed in accordance with (c) above.

*Exception: Where a grounding means does not exist in the receptacle enclosure either a nongrounding or a ground-fault circuit-interrupter-type of receptacle shall be used. A grounding conductor shall not be connected from the ground-fault circuit-interrupter-type receptacle to any outlet supplied from the ground-fault circuit-interrupter-type receptacle. Existing nongrounding-type receptacles shall be permitted to be replaced with grounding-type receptacles where supplied through a ground-fault circuit-interrupter-type receptacle.*

**(e) Cord- and Plug-Connected Equipment.** The installation of grounding-type receptacles shall not be used as a requirement that all cord- and plug-connected equipment be of the grounded type.

(FPN): See Section 250-45 for type of cord- and plug-connected equipment to be grounded.

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

### 210-8. Ground-Fault Circuit-Interrupter Protection for Personnel.

**(a) Dwelling Units.**

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

**(2)** All 125-volt, single-phase, 15- or 20-ampere receptacles installed in garages shall have ground-fault circuit-interrupter protection for personnel.

*Exception No. 1 to (a)(2): Receptacles which are not readily accessible.*

*Exception No. 2 to (a)(2): Receptacles for appliances occupying dedicated space which are cord- and plug-connected in accordance with Section 400-7(a)(6), (a)(7), or (a)(8).*

Receptacles installed under Exceptions to Section 210-8(a)(2) shall not be considered as meeting the requirements of Section 210-52(g).

**(3)** All 125-volt, single-phase, 15- and 20-ampere receptacles installed outdoors where there is direct grade level access to the dwelling unit and to the receptacles shall have ground-fault circuit-interrupter protection for personnel.

(FPN): See Section 215-9 for feeder protection.

For the purposes of this section, "direct grade level access" is defined as being located not more than 6 feet, 6 inches (1.98 m) above grade level and being readily accessible.

**(4)** All 125-volt, single-phase, 15- and 20-ampere receptacles installed in crawl spaces at or below grade level and in unfinished basements shall have ground-fault circuit-interrupter protection for personnel.

*Exception No. 1: A single receptacle supplied by a dedicated branch circuit which is located and identified for specific use by a cord- and plug-connected appliance, such as a refrigerator or freezer.*

*Exception No. 2: The laundry circuit as required by Sections 210-52(f) and 220-4(c).*

*Exception No. 3: A single receptacle supplying a permanently installed sump pump.*

**(5)** All 125-volt, single-phase, 15- and 20-ampere receptacles installed within 6 feet (1.83 m) of a kitchen sink to serve counter top surfaces shall have ground-fault circuit-interrupter protection for personnel.

(FPN): The intent of this subsection is to permit the exemption of receptacles which are located specifically for appliances such as refrigerators and freezers from ground-fault circuit-interrupter protection for personnel.

**(6)** All 125-volt, single-phase, 15- or 20-ampere receptacles installed in boathouses shall have ground-fault circuit-interrupter protection for personnel.

**Bathroom:** As used in Section 210-8, a bathroom is an area including a basin with one or more of the following: a toilet, a tub, or a shower.

**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 having 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 Section 422-21(b) for an appliance; Section 424-20 for a fixed electric space heating unit; Section 426-51 in the NEC for electric de-icing and snow-melting equipment; Section 430-85 in the NEC for a motor controller; and Section 430-103 in the NEC for a motor.

## B. Branch-Circuit Ratings

### 210-19. Conductors – Minimum Ampacity and Size.

**(a) General.** Branch-circuit conductors shall have an ampacity not less than the maximum load to be served. In addition, conductors of multioutlet branch circuits supplying receptacles for cord- and plug-connected portable loads shall have an ampacity of not less than the rating of the branch circuit. Cable assemblies with the neutral conductor smaller than the ungrounded conductors shall be so marked.

(FPN No. 1): See Table 310-16 for ampacity ratings of conductors.

(FPN No. 2): See Part B of Article 430 in the NEC for minimum rating of motor branch-circuit conductors.

(FPN No. 3): See Section 310-10 for temperature limitation of conductors.

(FPN No. 4): 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, will provide reasonable efficiency of operation. See Section 215-2 for voltage drop on feeder conductors.

**(b) 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: Tap conductors supplying electric ranges, wall-mounted electric ovens, and counter-mounted electric cooking units from a 50-ampere branch circuit shall have an ampacity of not less than 20 and shall be sufficient for the load to be served. 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 computed according to Column A of Table 220-19, but shall have an ampacity of not less than 70 percent of the branch-circuit rating and shall not be smaller than No. 10.*

**(c) Other Loads.** Branch-circuit conductors supplying loads other than cooking appliances as covered in (b) above and as listed in Section 210-2 shall have an ampacity sufficient for the loads served and shall not be smaller than No. 14.

*Exception No. 1: Tap conductors for such loads shall have an ampacity 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:*

*a. Individual lampholders or fixtures with taps extending not longer than 18 inches (457 mm) beyond any portion of the lampholder or fixture.*

*b. A fixture having tap conductors as provided in Section 410-67.*

*c. Individual outlets with taps not over 18 inches (457 mm) long.*

*e. Nonheating leads of de-icing and snow-melting cables and mats.*

*Exception No. 2: Fixture wires and cords as permitted in Section 240-4 in the NEC.*

**210-20. Overcurrent Protection.** Branch-circuit conductors and equipment shall be protected by overcurrent protective devices having a rating or setting (1) not exceeding that specified in Section 240-3 for conductors; (2) not exceeding that specified in the applicable articles referenced in Section 240-2 for equipment; and (3) as provided for outlet devices in Section 210-21.

*Exception No. 1: Tap conductors as permitted in Section 210-19(c) shall be permitted to be protected by the branch-circuit overcurrent device.*

*Exception No. 2: Fixture wires and cords as permitted in Section 240-4 in the NEC.*

(FPN): See Section 240-1 for the purpose of overcurrent protection and Sections 210-22 and 220-3 for continuous loads.

**210-21. Outlet Devices.** Outlet devices shall have an ampere rating not less than the load to be served and shall comply with (b) below.

**(b) Receptacles.**

**(1)** A single receptacle installed on an individual branch circuit shall have an ampere rating of not less than that of the branch circuit.

(FPN): See definition of Receptacle in Article 100.

**(2)** 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).

**(3)** Where connected to a branch circuit supplying two or more receptacles or outlets, receptacle ratings shall conform to the values listed in Table 210-21(b)(3) or where larger than 50 amperes, the receptacle rating shall not be less than the branch-circuit rating.

**(4)** It shall be permitted to base the ampere rating of a range receptacle on a single range demand load specified in Table 220-19.

**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 |

**Table 210-21(b)(3).**
**Receptacle Ratings for Various Size Circuits**

| Circuit Rating Amperes | Receptacle Rating Amperes |
|---|---|
| 15 | Not over 15 |
| 20 | 15 or 20 |
| 30 | 30 |
| 40 | 40 or 50 |
| 50 | 50 |

**210-22. Maximum Loads.** The total load shall not exceed the rating of the branch circuit, and it shall not exceed the maximum loads specified in (a) through (c) below under the conditions specified therein.

**(a) Motor-Operated and Combination Loads.** Where a circuit supplies only motor-operated loads, Article 430 shall apply. Where a circuit supplies only air-conditioning and/or refrigerating equipment, Article 440 shall apply. For circuits supplying loads consisting of motor-operated utilization equipment that is fastened in place and that has a motor larger than $\frac{1}{8}$ horsepower in combination with other loads, the total computed load shall be based on 125 percent of the largest motor load plus the sum of the other loads.

**(b) Inductive Lighting Loads.** For circuits supplying lighting units having ballasts, transformers, or autotransformers, the computed load shall be based on the total ampere ratings of such units and not on the total watts of the lamps.

**(c) Other Loads.** It shall be acceptable to apply demand factors for range loads in accordance with Table 220-19, including Note 4.

**210-23. Permissible Loads.** In no case shall the load exceed the branch-circuit ampere rating. An individual branch circuit shall be permitted to supply any load for which it is rated. A branch circuit supplying two or more outlets shall supply only the loads specified according to its size in (a) through (c) below and summarized in Section 210-24 and Table 210-24.

**(a) 15- and 20-Ampere Branch Circuits.** A 15- or 20-ampere branch circuit shall be permitted to supply lighting units, other utilization equipment, or a combination of both. The rating of any one cord- and plug-connected utilization equipment shall not exceed 80 percent of the branch-circuit ampere rating. The total rating of utilization equipment fastened in place 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.

*Exception: The small appliance branch circuits required in a dwelling unit(s) by Section 220-4(b) shall supply only the receptacle outlets specified in that section.*

**(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 dwelling unit(s) or utilization equipment in any occupancy. A 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.

**210-24. Branch-Circuit Requirements — Summary.** The requirements for circuits having two or more outlets, other than the receptacle circuits of Section 220-4(b) as specifically provided for above, are summarized in Table 210-24. Branch circuits in dwelling units shall not be connected to serve more than one dwelling unit.

*Exception: Branch circuits in two-family or multifamily dwellings, with dwelling units under single management, shall be permitted to be connected to serve more than one dwelling unit for the purpose of central alarm, signal, communications, or similar functions.*

### C. Required Outlets

**210-50. General.** Receptacle outlets shall be installed as specified in Section 210-52.

**(a) Cord Pendants.** A cord connector that is supported by a permanently installed cord pendant shall be considered a receptacle outlet.

**Table 210-24.**
**Summary of Branch-Circuit Requirements**

(Type FEP, FEPB, SA, TW, RH, RHW, RHH, THHN, THW, THWN, and XHHW conductors in raceway or cable.)

| CIRCUIT RATING | 15 Amp | 20 Amp | 30 Amp | 40 Amp | 50 Amp |
|---|---|---|---|---|---|
| CONDUCTORS (Min. Size) | | | | | |
| Circuit Wires* | 14 | 12 | 10 | 8 | 6 |
| Taps | 14 | 14 | 14 | 12 | 12 |
| Fixture Wires and Cords | | | Refer to Section 240-4 | | |
| OVERCURRENT PROTECTION | 15 Amp | 20 Amp | 30 Amp | 40 Amp | 50 Amp |
| OUTLET DEVICES: | | | | | |
| Lampholders Permitted | Any Type | Any Type | Heavy Duty | Heavy Duty | Heavy Duty |
| Receptacle Rating** | 15 Max. Amp | 15 or 20 Amp | 30 Amp | 40 or 50 Amp | 50 Amp |
| MAXIMUM LOAD | 15 Amp | 20 Amp | 30 Amp | 40 Amp | 50 Amp |
| PERMISSIBLE LOAD | Refer to Section 210-23(a) | Refer to Section 210-23(a) | Refer to Section 210-23(b) | Refer to Section 210-23(c) | Refer to Section 210-23(c) |

* These gages are for copper conductors.
** For receptacle rating of cord-connected electric-discharge lighting fixtures, see Section 410-30(c).

**(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, it shall be permitted to omit receptacles for such cords.

**(c) Laundry Outlet.** Appliance outlets installed in a dwelling unit for specific appliances, such as laundry equipment, shall be installed within 6 feet (1.83 m) of the intended location of the appliance.

## 210-52. Dwelling Unit Receptacle Outlets.

**(a) General Provisions.** In every kitchen, family room, dining room, living room, parlor, library, den, sun room, bedroom, recreation room, or similar room or area of dwelling units, receptacle outlets shall be installed so that no point along the floor line in any wall space is more than 6 feet (1.83 m), measured horizontally, from an outlet in that space, including any wall space 2 feet (610 mm) or more in width and the wall space occupied by fixed panels in exterior walls, but excluding sliding panels in exterior walls. The wall space afforded by fixed room dividers, such as free-standing bar-type counters, shall be included in the 6-foot (1.83-m) measurement.

As used in this section a "wall space" shall be considered a wall unbroken along the floor line by doorways, fireplaces, and similar openings. Each wall space 2 or more feet (610 mm or more) wide shall be treated individually and separately from other wall spaces within the room. A wall space shall be permitted to include two or more walls of a room (around corners) where unbroken at the floor line.

(FPN): The purpose of this requirement is to minimize the use of cords across doorways, fireplaces, and similar openings.

Receptacle outlets shall, insofar as practicable, be spaced equal distances apart. Receptacle outlets in floors shall not be counted as part of the required number of receptacle outlets unless located close to the wall.

The receptacle outlets required by this section shall be in addition to any receptacle that is part of any lighting fixture or appliance, located within cabinets or cupboards, or located over 5½ feet (1.68 m) above the floor.

*Exception: 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.*

(FPN): Listed baseboard heaters include instructions which may not permit their installation below receptacle outlets.

**(b) Small Appliances.**

**(1)** The two or more 20-ampere small appliance branch circuits required by Section 220-4(b) shall serve all receptacle outlets, including refrigeration equipment, in the kitchen, pantry, breakfast room, dining room, or similar area of a dwelling unit. Such circuits, whether two or more are used, 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 above.*

*Exception No. 2: Outdoor receptacles.*

*Exception No. 3: In addition to the required receptacles specified by Section 210-52, switched receptacles supplied from a general-purpose branch circuit as defined in Section 210-70(a), Exception No. 1 shall be permitted.*

**(2)** Receptacles installed in the kitchen to serve counter top surfaces shall be supplied by not less than two small appliance branch circuits, either or both of which shall also be permitted to supply receptacle outlets in the kitchen and other rooms specified in (b)(1) above. Additional small appliance branch circuits shall be permitted to supply receptacle outlets in the kitchen and other rooms specified in (b)(1) above.

**(c) Counter Tops.** In kitchens and dining areas of dwelling units a receptacle outlet shall be installed at each counter space wider than 12 inches (305 mm). Receptacles shall be installed so that no point along the wall line is more than 24 inches (610 mm), measured horizontally from a receptacle outlet in that space. Island and peninsular counter tops 12 inches (305 mm) or wider shall have at least one receptacle for each four feet (1.22 m) of counter top. Counter top spaces separated by range tops, refrigerators, or sinks shall be considered as separate counter top spaces. Receptacles rendered inaccessible by appliances fastened in place or appliances occupying dedicated space shall not be considered as these required outlets.

**(d) Bathrooms.** In dwelling units at least one wall receptacle outlet shall be installed in the bathroom adjacent to the basin location. See Section 210-8(a)(1).

**(e) Outdoor Outlets.** For a one-family dwelling at least one receptacle outlet accessible at grade level shall be installed outdoors. One-family dwelling units with no direct outdoor grade level access from front to back shall have one receptacle at the front and one at the back. For a two-family dwelling, at least one receptacle outlet accessible at grade level shall be installed outdoors for each dwelling unit which is at grade level. See Section 210-8(a)(3).

**(f) Laundry Areas.** In dwelling units at least one receptacle outlet shall be installed for the laundry.

*Exception No. 1: In a dwelling unit that is an apartment or living area in a multifamily building where laundry facilities are provided on the premises that are available to all building occupants, a laundry receptacle shall not be required.*

*Exception No. 2: In other than one-family dwellings where laundry facilities are not to be installed or permitted, a laundry receptacle shall not be required.*

**(g) Basements and Garages.** For a one-family dwelling, at least one receptacle outlet, in addition to any provided for laundry equipment, shall be installed in each basement and in each attached garage, and in each detached garage with electric power. See Sections 210-8(a)(2) and (a)(4).

**(h) Hallways.** For hallways of 10 feet (3.05 m) or more in length at least one receptacle outlet shall be required.

As used in this subsection the hall length shall be considered the length along the centerline of the hall without passing through a doorway.

**210-63. Heating, Air-Conditioning, and Refrigeration Equipment Outlet.** A 125-volt, single-phase, 15- or 20-ampere-rated receptacle outlet shall be installed at an accessible location for the servicing of heating, air-conditioning, and refrigeration equipment on rooftops and in attics and crawl spaces. The receptacle shall be located on the same level and within 75 feet (22.86 m) of the heating, air-conditioning, and refrigeration equipment. The receptacle outlet shall not be connected to the load side of the equipment disconnecting means.

*Exception: Rooftop equipment on one- and two-family dwellings.*

**210-70. Lighting Outlets Required.** Lighting outlets shall be installed where specified in (a) and (b) below.

**(a) Dwelling Unit(s).** At least one wall switch-controlled lighting outlet shall be installed in every habitable room; in bathrooms, hallways, stairways, attached garages, and detached garages with electric power; and at outdoor entrances or exits.

(FPN): A vehicle door in an attached garage is not considered as an outdoor entrance.

At least one lighting outlet controlled by a light switch located at the point of entry to the attic, underfloor space, utility room, and basement shall be installed only where these spaces are used for storage or contain equipment requiring servicing. The lighting outlet shall be provided at or near the equipment requiring servicing.

Where lighting outlets are installed according to (a) above in interior stairways, there shall be a wall switch at each floor level to control the lighting outlet where the difference between floor levels is six steps or more.

*Exception No. 1: In habitable rooms, other than kitchens and bathrooms, one or more receptacles controlled by a wall switch shall be permitted in lieu of lighting outlets.*

*Exception No. 2: In hallways, stairways, and at outdoor entrances remote, central, or automatic control of lighting shall be permitted.*

## ARTICLE 215 — FEEDERS

**215-1. Scope.** This article covers the installation requirements and minimum size and ampacity of conductors for feeders supplying branch-circuit loads as computed in accordance with Article 220.

**215-2. Minimum Rating and Size.** Feeder conductors shall have an ampacity not lower than required to supply the load as computed in Parts B and C of Article 220. The minimum sizes shall be as specified in (a) and (b) below under the conditions stipulated. Feeder conductors for a dwelling unit need not be larger than service-entrance conductors. Note 3 of Table 310-16 shall be permitted to be used for conductor size.

**(a) For Specified Circuits.** The ampacity of feeder conductors shall not be less than 30 amperes where the load supplied consists of any of the following number and types of circuits: (1) two or more 2-wire branch circuits supplied by a 2-wire feeder; (2) more than two 2-wire branch circuits supplied by a 3-wire feeder; or (3) two or more 3-wire branch circuits supplied by a 3-wire feeder.

**(b) Ampacity Relative to Service-Entrance Conductors.** The feeder conductor ampacity shall not be lower than that of the service-entrance conductors where the feeder conductors carry the total load supplied by service-entrance conductors with an ampacity of 55 amperes or less.

(FPN): See Examples 1(a), 1(b), 2(a), and 2(b) in Tables and Examples.

**215-3. Overcurrent Protection.** Feeders shall be protected against overcurrent in accordance with the provisions of Part A of Article 240.

**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 connected load before applying demand factors, the demand factors used, the computed load after applying demand factors, and the size and type of conductors to be used.

**215-6. Feeder Conductor Grounding Means.** Where a feeder supplies branch circuits in which equipment grounding conductors are required, the feeder shall include or provide a grounding means in accordance with the provisions of Section 250-57 to which the equipment grounding conductors of the branch circuits shall be connected.

**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 Protection for Personnel.** Feeders supplying 15- and 20-ampere receptacle branch circuits shall be permitted to be protected by a ground-fault circuit-interrupter in lieu of the provisions for such interrupters as specified in Section 210-8 and Article 305.

## ARTICLE 220 — BRANCH-CIRCUIT AND FEEDER CALCULATIONS

### A. General

**220-1. Scope.** This article provides requirements for determining the number of branch circuits required and for computing branch-circuit and feeder loads.

**220-2. Voltages.** Unless other voltages are specified, for purposes of computing branch-circuit and feeder loads, nominal system voltages of 120, 120/240, 208Y/120, and 240 volts shall be used.

**220-3. Computation of Branch Circuits.** Branch-circuit loads shall be computed as shown in (a) through (d) below.

**(a) Continuous and Noncontinuous Loads.** The branch-circuit rating shall not be less than the noncontinuous load plus 125 percent of the continuous load.

*Exception: Where the assembly, including overcurrent devices, is listed for continuous operation of 100 percent of its rating.*

**(b) Lighting Load for Listed Occupancies.** A unit load of not less than that specified in Table 220-3(b) for occupancies listed therein shall constitute the minimum lighting load for each square foot (0.093 sq m) of floor area. The floor area for each floor shall be computed from the outside dimensions of the building, apartment, or other area involved. For dwelling unit(s), the computed floor area shall not include open porches, garages, or unused or unfinished spaces not adaptable for future use.

(FPN): The unit values herein are based on minimum load conditions and 100 percent power factor, and may not provide sufficient capacity for the installation contemplated.

**Table 220-3(b). General Lighting Loads by Occupancies**

| Type of Occupancy | Unit Load per Sq. Ft. (Volt-Amperes) |
|---|---|
| *Dwelling Units | 3 |

For SI units: one square foot = 0.093 square meter.

* All general use receptacle outlets of 20-ampere or less rating in one-family, two-family and multifamily dwellings and in guest rooms of hotels and motels [except those connected to the receptacle circuits specified in Sections 220-4(b) and (c)] shall be considered as outlets for general illumination, and no additional load calculations shall be required for such outlets.

**(c) Other Loads — All Occupancies.** In all occupancies the minimum load for each outlet for general-use receptacles and outlets not used for general illumination shall be not less than the following, the loads shown being based on nominal branch-circuit voltages.

**(1)** Outlet for a specific appliance or other load except for a motor load ..... ampere rating of appliance or load served.

**(2)** Outlet for motor load ..... See Sections 430-22 and 430-24 and Article 440.

**(3)** An outlet supplying recessed lighting fixture(s) shall be the maximum volt-ampere rating of the equipment and lamps for which the fixture(s) is rated.

**(4)** Outlet for heavy-duty lampholder ..... 600 volt-amperes.

**(5)** *Other outlets ..... 180 volt-amperes per outlet.

For receptacle outlets, each single or each multiple receptacle on one strap shall be considered at not less than 180 volt-amperes.

* This provision shall not be applicable to receptacle outlets connected to the circuit specified in Section 220-4(b).

*Exception No. 2: Table 220-19 shall be permitted for computing the load of household electric ranges.*

*Exception No. 5: Section 220-18 shall be considered as a permitted method of computing the load for a household electric clothes dryer.*

**(d) Loads for Additions to Existing Installations.**

**(1) Dwelling Units.** Loads for structural additions to an existing dwelling unit or to a previously unwired portion of an existing dwelling unit, either of which exceeds 500 square feet (46.5 sq m), shall be computed in accordance with (b) above. Loads for new circuits or extended circuits in previously wired dwelling units shall be computed in accordance with either (b) or (c) above.

**220-4. Branch Circuits Required.** Branch circuits for lighting and for appliances, including motor-operated appliances, shall be provided to supply the loads computed in accordance with Section 220-3. In addition, branch circuits shall be provided for specific loads not covered by Section 220-3 where required elsewhere in this Code; for small appliance loads as specified in (b) below; and for laundry loads as specified in (c) below.

**(a) Number of Branch Circuits.** The minimum number of branch circuits shall be determined from the total computed 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 Section 210-22.

**(b) Small Appliance Branch Circuits — Dwelling Unit.** In addition to the number of branch circuits determined in accordance with (a) above, two or more 20-ampere small appliance branch circuits shall be provided for all receptacle outlets specified by Section 210-52 for the small appliance loads.

**(c) Laundry Branch Circuits – Dwelling Unit.** In addition to the number of branch circuits determined in accordance with (a) and (b) above, at least one additional 20-ampere branch circuit shall be provided to supply the laundry receptacle outlet(s) required by Section 210-52(f). This circuit shall have no other outlets.

**(d) Load Evenly Proportioned Among Branch Circuits.** Where the load is computed on a volt-amperes-per-square-foot (0.093-sq m) basis, 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 need only be installed to serve the connected load.

(FPN): See Examples 1(a), 1(b), and 2(b) in Tables and Examples.

## B. Feeders

### 220-10. General.

**(a) Ampacity and Computed Loads.** Feeder conductors shall have sufficient ampacity to supply the load served. In no case shall the computed load of a feeder be less than the sum of the loads on the branch circuits supplied as determined by Part A of this article after any applicable demand factors permitted by Parts B or C have been applied.

**(b) Continuous and Noncontinuous Loads.** 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) are listed for operation at 100 percent of their rating, neither the ampere rating of the overcurrent device nor the ampacity of the feeder conductors shall be less than the sum of the continuous load plus the noncontinuous load.*

**220-11. General Lighting.** The demand factors listed in Table 220-11 shall apply to that portion of the total branch-circuit load computed for general illumination. They shall not be applied in determining the number of branch circuits for general illumination.

(FPN): See Section 220-16 for application of demand factors to small appliance and laundry loads in dwellings.

**Table 220-11. Lighting Load Feeder Demand Factors**

| Type of Occupancy | Portion of Lighting Load to Which Demand Factor Applies (volt-amperes) | Demand Factor Percent |
|---|---|---|
| Dwelling Units | First 3000 or less at | 100 |
| | From 3001 to 120,000 at | 35 |
| | Remainder over 120,000 at | 25 |

**220-14. Motors.** Motor loads shall be computed in accordance with Sections 430-24, 430-25, and 430-26 in the NEC.

**220-15. Fixed Electric Space Heating.** Fixed electric space heating loads shall be computed at 100 percent of the total connected load; however in no case shall a feeder load current rating be less than the rating of the largest branch circuit supplied.

*Exception No. 1: Where reduced loading of the conductors results from units operating on duty-cycle, intermittently, or from all units not operating at one time, the authority having jurisdiction may grant permission for feeder conductors to have an ampacity less than 100 percent, provided the conductors have an ampacity for the load so determined.*

*Exception No. 2: The use of the optional calculations in Sections 220-30 and 220-31 shall be permitted for fixed electric space heating loads in a dwelling unit.*

**220-16. Small Appliance and Laundry Loads — Dwelling Unit.**

**(a) Small Appliance Circuit Load.** In each dwelling unit the feeder load shall be computed at 1500 volt-amperes for each 2-wire small appliance branch circuit required by Section 220-4(b) for small appliances supplied by 15- or 20-ampere receptacles on 20-ampere branch circuits in the kitchen, pantry, dining room, and breakfast room. Where the load is subdivided through two or more feeders, the computed load for each shall include not less than 1500 volt-amperes for each 2-wire branch circuit for small appliances. These loads shall be permitted to be included with the general lighting load and subjected to the demand factors permitted in Table 220-11 for the general lighting load.

**(b) Laundry Circuit Load.** A feeder load of not less than 1500 volt-amperes shall be included for each 2-wire laundry branch circuit installed as required by Section 220-4(c). It shall be permissible to include this load with the general lighting load and subject it to the demand factors provided in Section 220-11.

**220-17. Appliance Load — Dwelling Unit(s).** It shall be permissible to apply a demand factor of 75 percent to the nameplate-rating load of four or more appliances fastened in place served by the same feeder in a one-family or two-family dwelling.

*Exception: This demand factor shall not be applied to electric ranges, clothes dryers, space heating equipment, or air-conditioning equipment.*

**220-18. Electric Clothes Dryers — Dwelling Unit(s).** The load for household electric clothes dryers in a dwelling unit(s) shall be 5000 watts (volt-amperes) or the nameplate rating, whichever is larger, for each dryer served. The use of the demand factors in Table 220-18 shall be permitted.

**220-19. Electric Ranges and Other Cooking Appliances — Dwelling Unit(s).** The feeder demand load for household electric ranges, wall-mounted ovens, counter-mounted cooking units, and other household cooking appliances individually rated in excess of 1¾ kW shall be permitted to be computed in accordance with Table 220-19. Where two or more single-phase ranges are supplied by a 3-phase, 4-wire feeder, the total load shall be computed on the basis of twice the maximum number connected between any two phases. kVA shall be considered equivalent to kW for loads computed under this section.

**Table 220-18**
**Demand Factors for Household Electric Clothes Dryers**

| Number of Dryers | Demand Factor Percent |
|---|---|
| 1 | 100 |
| 2 | 100 |

**Table 220-19. Demand Loads for Household Electric Ranges, Wall-Mounted Ovens, Counter-Mounted Cooking Units, and Other Household Cooking Appliances over 1¾ kW Rating. Column A to be used in all cases except as otherwise permitted in Note 3 below.**

| NUMBER OF APPLIANCES | Maximum Demand (See Notes) | Demand Factors Percent (See Note 3) | |
|---|---|---|---|
| | COLUMN A (Not over 12 kW Rating) | COLUMN B (Less than 3½ kW Rating) | COLUMN C (3½ kW to 8¾ kW Rating) |
| 1 | 8 kW | 80% | 80% |
| 2 | 11 kW | 75% | 65% |
| 3 | 14 kW | 70% | 55% |
| 4 | 17 kW | 66% | 50% |
| 5 | 20 kW | 62% | 45% |
| 6 | 21 kW | 59% | 43% |

Note 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 A shall be increased 5 percent for each additional kW of rating or major fraction thereof by which the rating of individual ranges exceeds 12 kW.

Note 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 computed 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; and then the maximum demand in Column A shall be increased 5 percent for each kW or major fraction thereof by which this average value exceeds 12 kW.

Note 3. Over 1¾ kW through 8¾ kW. In lieu of the method provided in Column A, it shall be permissible to add the nameplate ratings of all ranges rated more than 1¾ kW but not more than 8¾ kW and multiply the sum by the demand factors specified in Column B or C for the given number of appliances.

Note 4. Branch-Circuit Load. It shall be permissible to compute the branch-circuit load for one range in accordance with Table 220-19. The branch-circuit load for one wall-mounted oven or one counter-mounted cooking unit shall be the nameplate rating of the appliance. 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 computed by adding the nameplate rating of the individual appliances and treating this total as equivalent to one range.

Note 5. This table also applies to household cooking appliances rated over 1¾ kW and used in instructional programs.

(FPN): See Examples 1(a), 1(b), 2(a), and 2(b) in Tables and Examples.

**220-21. Noncoincident Loads.** Where it is unlikely that two dissimilar loads will be in use simultaneously, it shall be permissible to omit the smaller of the two in computing the total load of a feeder.

**220-22. Feeder Neutral Load.** The feeder neutral load shall be the maximum unbalance of the load determined by this article. The maximum unbalanced load shall be the maximum net computed load between the neutral and any one ungrounded conductor. For a feeder supplying household electric ranges, wall-mounted ovens, counter-mounted cooking units, and electric dryers the maximum unbalanced load shall be considered as 70 percent of the load on the ungrounded conductors, as determined in accordance with Table 220-19 for ranges and Table 220-18 for dryers.

(FPN): See Examples 1(a), 1(b), and 2(b) in Tables and Examples.

### C. Optional Calculations for Computing Feeder and Service Loads

**220-30. Optional Calculation — Dwelling Unit.**

**(a) Feeder and Service Load.** For a dwelling unit having the total connected load served by a single 3-wire, 120/240-volt or 208Y/120-volt set of service-entrance or feeder conductors with an ampacity of 100 or greater, it shall be permissible to compute the feeder and service loads in accordance with Table 220-30 instead of the method specified in Part B of this article. Feeder and service-entrance conductors whose demand load is determined by this optional calculation shall be permitted to have the neutral load determined by Section 220-22.

**Table 220-30.**
**Optional Calculation for Dwelling Unit**
**Load in kVA**

| |
|---|
| Largest of the following five selections. |
| (1) 100 percent of the nameplate rating(s) of the air conditioning and cooling, including heat pump compressors. |
| (2) 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 figured under any other selection in this table. |
| (3) 65 percent of the nameplate rating(s) of the central electric space heating including integral supplemental heating in heat pumps. |
| (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 of four or more separately controlled units. |
| Plus: 100 percent of the first 10 kVA of all other load. 40 percent of the remainder of all other load. |

**(b) Loads.** The loads identified in Table 220-30 as "other load" and as "remainder of other load" shall include the following:

**(1)** 1500 volt-amperes for each 2-wire, 20-ampere small appliance branch circuit and each laundry branch circuit specified in Section 220-16.

**(2)** 3 volt-amperes per square foot (0.093 sq m) for general lighting and general-use receptacles.

(3) The nameplate rating of all appliances that are fastened in place, permanently connected, or located to be on a specific circuit, ranges, wall-mounted ovens, counter-mounted cooking units, clothes dryers, and water heaters.

(4) The nameplate ampere or kVA rating of all motors and of all low-power-factor loads.

**220-31. Optional Calculation for Additional Loads in Existing Dwelling Unit.** For an existing dwelling unit presently being served by an existing 120/240 volt or 208Y/120, 3-wire service, it shall be permissible to compute load calculations as follows:

| Load (in kVA) | Percent of Load |
|---|---|
| First 8 kVA of load at | 100% |
| Remainder of load at | 40% |

Load calculation shall include lighting at 3 volt-amperes per square foot (0.093 sq m); 1500 volt-amperes for each 20-ampere appliance circuit; range or wall-mounted oven and counter-mounted cooking unit, and other appliances that are permanently connected or fastened in place, at nameplate rating.

If air-conditioning equipment or electric space heating equipment is to be installed the following formula shall be applied to determine if the existing service is of sufficient size.

| | |
|---|---|
| Air-conditioning equipment* | 100% |
| Central electric space heating* | 100% |
| Less than four separately controlled space heating units* | 100% |
| First 8 kVA of all other load | 100% |
| Remainder of all other load | 40% |

Other loads shall include:

1500 volt-amperes for each 20-ampere appliance circuit.

Lighting and portable appliances at 3 volt-amperes per square foot (0.093 sq m)

Household range or wall-mounted oven and counter-mounted cooking unit.

All other appliances fastened in place, including four or more separately controlled space heating units, at nameplate rating.

* Use larger connected load of air conditioning and space heating, but not both.

## ARTICLE 230 — SERVICES

**230-1. Scope.** This article covers service conductors and equipment for control and protection of services and their installation requirements.

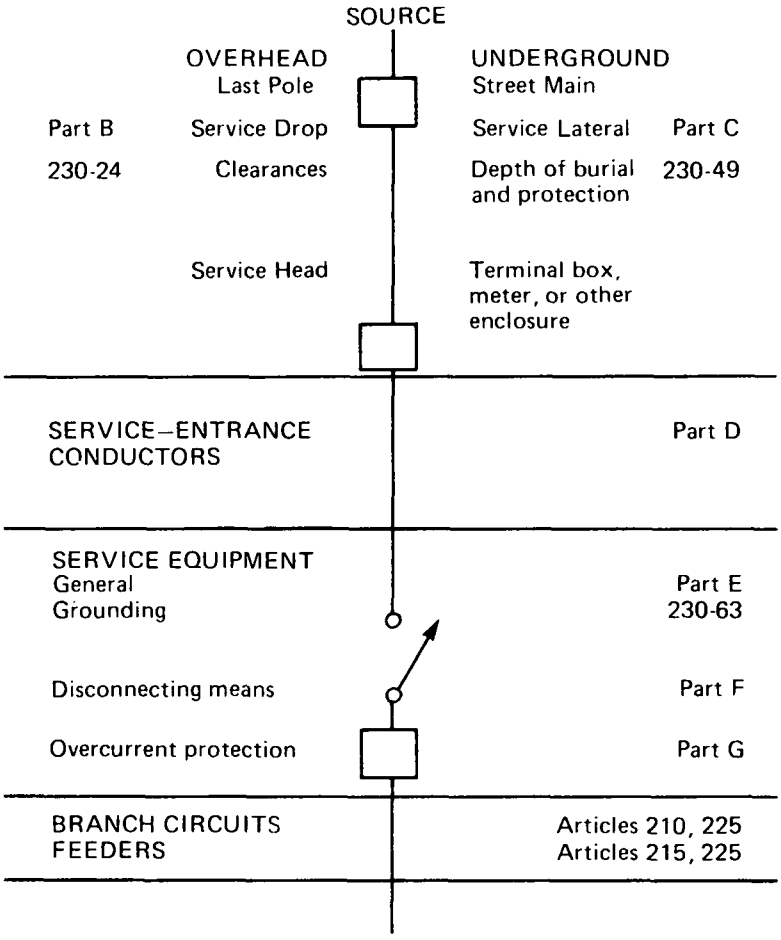
(FPN): See Diagram 230-1.

### A. General.

**230-2. Number of Services.** A building or other structure served shall be supplied by only one service.

**Diagram 230-1. Services**





Where more than one service is permitted by the following exception, a permanent plaque or directory shall be installed at each service drop or lateral or at each service-equipment location denoting all other services on or in that building or structure and the area served by each.

*Exception No. 6: For different characteristics, such as for different voltages, frequencies, or phases, or for different uses, such as for different rate schedules.*

**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.

(FPN): See Section 230-6 for concrete or masonry-encased conductors considered outside of a building.

**230-6. Conductors Considered Outside of 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 2 inches (50.8 mm) of concrete beneath a building or other structure; or (2) where installed within a building or other structure in a raceway that is encased in concrete or brick not less than 2 inches (50.8 mm) thick.

**230-8. Raceway Seal.** Where a service raceway enters from an underground distribution system, it shall be sealed in accordance with Section 300-5. Spare or unused raceways shall also be sealed. Sealants shall be identified for use with the cable insulation, shield, or other components.

**230-9. Clearance from Building Openings.** Service conductors installed as open conductors or multiconductor cable without an overall outer jacket shall have a clearance of not less than 3 feet (914 mm) from windows, doors, porches, fire escapes, or similar locations.

*Exception: Conductors run above the top level of a window shall be permitted to be less than the 3 feet (914 mm) requirement above.*

### B. Overhead Service-Drop Conductors

**230-21. Overhead Supply.** Overhead conductors to a building or other structure (such as a pole) on which a meter or disconnecting means is installed shall be considered as a service drop and installed accordingly.

**230-22. Insulation or Covering.** Service conductors shall normally withstand exposure to atmospheric and other conditions of use without detrimental leakage of current. Individual conductors shall be insulated or covered with an extruded thermoplastic or thermosetting insulating material.

*Exception: The grounded conductor of a multiconductor cable shall be permitted to be bare.*

**230-23. Size and Rating.**

**(a) General.** Conductors shall have sufficient ampacity to carry the load without a temperature rise detrimental to the covering or insulation of the conductors and shall have adequate mechanical strength.

**(b) Minimum Size.** The conductors shall not be smaller than No. 8 copper, No. 6 aluminum or copper-clad aluminum.

*Exception: For installations to supply only limited loads of a single branch circuit such as small polyphase power, controlled water heaters and the like, they shall not be smaller than No. 12 hard-drawn copper or equivalent.*

**(c) Grounded Conductors.** The grounded (neutral) conductor shall not be less than the minimum size as required by Section 250-23(b).

**230-24. Clearances.** The vertical clearances of all service-drop conductors shall be based on conductor temperature of 60°F (15°C), no wind, with final unloaded sag in the wire, conductor, or cable.

Service-drop conductors shall not be readily accessible and shall comply with (a) through (d) below for services not over 600 volts, nominal.

**(a) Above Roofs.** Conductors shall have a vertical clearance of not less than 8 feet (2.44 m) from the roof surface. The vertical clearance shall be maintained for a distance not less than 3 feet (914 mm) 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 Section 230-24(b).*

*Exception No. 2: Where the voltage between conductors does not exceed 300 and the roof has a slope of not less than 4 inches (102 mm) in 12 inches (305 mm), a reduction in clearance to 3 feet (914 mm) 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 18 inches (457 mm) shall be permitted if (1) not more than 4 feet (1.22 m) of service-drop conductors pass above the roof overhang, and (2) they are terminated at a through-the-roof raceway or approved support.*

(FPN): See Section 230-28 for mast supports.

**(b) Vertical Clearance from Ground.** Service-drop conductors where not in excess of 600 volts, nominal, shall have the following minimum clearance from final grade.

10 feet (3.05 m) — at the electric service entrance to buildings, or at the drip loop of the building electric entrance, or above areas or sidewalks accessible only to pedestrians, measured from final grade or other accessible surface only for service-drop cables supported on and cabled together with a grounded bare messenger and limited to 150 volts to ground.

12 feet (3.66 m) — for those areas listed in the 15 foot (4.57 m) classification when the voltage is limited to 300 volts to ground.

15 feet (4.57 m) — over residential property and driveways, and those commercial areas not subject to truck traffic.

18 feet (5.49 m) — 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.

**(c) Clearance from Building Openings.** See Section 230-9.

**(d) Clearance from Swimming Pools.** See Section 680-8.

**230-26. Point of Attachment.** The point of attachment of the service-drop conductors to a building or other structure shall provide the minimum clearances as specified in Section 230-24. In no case shall this point of attachment be less than 10 feet (3.05 m) above finished grade.

**230-27. Means of Attachment.** Multiconductor cables used for service drops 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.** Where a service mast is used for the support of service-drop conductors, it shall be of adequate strength or be supported by braces or guys to withstand safely the strain imposed by the service drop. Where raceway-type service masts are used, all raceway fittings shall be identified for use with service masts.

**230-29. Supports Over Buildings.** Service-drop conductors passing over a roof shall be securely supported by substantial structures. Where practicable, such supports shall be independent of the building.

### C. Underground Service-Lateral Conductors

**230-30. Insulation.** Service-lateral conductors shall withstand exposure to atmospheric and other conditions of use without detrimental leakage of current. Service-lateral conductors shall be insulated for the applied voltage.

*Exception: A grounded conductor shall be permitted to be uninsulated as follows:*

*a. Bare copper used in a raceway.*

*b. Bare copper for direct burial where bare copper is judged to be suitable for the soil conditions.*

*c. Bare copper for direct burial without regard to soil conditions where part of a cable assembly identified for underground use.*

*d. 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.*

**230-31. Size and Rating.**

**(a) General.** Service-lateral conductors shall have sufficient ampacity to carry the current for the load as computed in accordance with Article 220 and shall have adequate mechanical strength.

**(b) Minimum Size.** The conductors shall not be smaller than No. 8 copper or No. 6 aluminum or copper-clad aluminum.

*Exception: For installations to supply only limited loads of a single branch circuit such as small polyphase power, controlled water heaters and the like, they shall not be smaller than No. 12 copper or No. 10 aluminum or copper-clad aluminum.*

**(c) Grounded Conductors.** The grounded (neutral) conductor shall not be less than the minimum size required by Section 250-23(b).

(FPN): Reasonable efficiency of operation can be provided when voltage drop is taken into consideration in sizing the service-lateral conductors.

**230-32. Protection Against Damage.** Underground service-lateral conductors shall be protected against damage in accordance with Section 300-5. Service-lateral conductors entering a building shall be installed in accordance with Section 230-6 or protected by a raceway wiring method identified in Section 230-43.

### D. Service-Entrance Conductors

**230-40. Number of Service-Entrance Conductor Sets.** Each service drop or lateral shall supply only one set of service-entrance conductors.

*Exception No. 1: Two-family dwellings shall be permitted to have one set of service-entrance conductors run to each occupancy.*

*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 or lateral, one set of service-entrance conductors shall be permitted to supply each or several such service equipment enclosures.*

**230-41. Insulation of Service-Entrance Conductors.** Service-entrance conductors shall normally withstand exposure to atmospheric and other conditions of use without detrimental leakage of current. 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:*

*a. Bare copper used in a raceway or part of a service cable assembly.*

*b. Bare copper for direct burial where bare copper is judged to be suitable for the soil conditions.*

*c. Bare copper for direct burial without regard to soil conditions when part of a cable assembly identified for underground use.*

*d. Aluminum or copper-clad aluminum without individual insulation or covering when part of a cable assembly or identified for underground use in a raceway or for direct burial.*

**230-42. Size and Rating.**

**(a) General.** Service-entrance conductors shall be of sufficient size to carry the loads as computed in Article 220. Ampacity shall be determined from Table 310-16.

**(b) Ungrounded Conductors.** Ungrounded conductors shall have an ampacity of not less than:

(1) 100 ampere for a 3-wire service to a one-family dwelling with six or more 2-wire branch circuits.

**(2)** 100 ampere for a 3-wire service to a one-family dwelling with an initial net computed load of 10 kVA or more.

**(3)** 60 amperes for other loads.

*Exception No. 1: For loads consisting of not more than two 2-wire branch circuits, No. 8 copper or No. 6 aluminum or copper-clad aluminum.*

*Exception No. 2: By special permission, for loads limited by demand or by the source of supply, No. 8 copper or No. 6 aluminum or copper-clad aluminum.*

*Exception No. 3: For limited loads of a single branch circuit, No. 12 copper or No. 10 aluminum or copper-clad aluminum, but in no case smaller than the branch-circuit conductors.*

**(c) Grounded Conductors.** The grounded (neutral) conductor shall not be less than the minimum size as required by Section 250-23(b).

**230-43. Wiring Methods for 600 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 limited to the following methods: (1) open wiring on insulators; (2) rigid metal conduit; (3) intermediate metal conduit; (4) electrical metallic tubing; (5) service-entrance cables; (6) wireways; (9) rigid nonmetallic conduit; (11) Type MC cable; (13) flexible metal conduit not over 6 feet (1.83 m) long between raceways, or between raceway and service equipment, with equipment bonding jumper routed with the flexible metal conduit according to provisions of Section 250-79(a), (b), (c), (d), and (f); or (14) liquidtight flexible nonmetallic conduit. Also see Section 350-2.

**230-46. Unspliced Conductors.** Service-entrance conductors shall not be spliced.

*Exception No. 1: Clamped or bolted connections in metering equipment enclosures shall be permitted.*

*Exception No. 2: Where service-entrance conductors are tapped to supply two to six disconnecting means grouped at a common location.*

*Exception No. 3: At a properly enclosed junction point where an underground wiring method is changed to another type of wiring method.*

*Exception No. 4: A connection shall be permitted where service conductors are extended from a service drop to an outside meter location and returned to connect to the service-entrance conductors of an existing installation.*

**230-49. Protection Against Physical Damage – Underground.** Underground service-entrance conductors shall be protected against physical damage in accordance with Section 300-5.

**230-50. Protection of Open Conductors and Cables Against Damage – Aboveground.** Service-entrance conductors installed aboveground shall be protected against physical damage as specified in (a) or (b) below.

**(a) Service-Entrance Cables.** Service-entrance cables, where subject to physical damage, such as where installed in exposed places near sidewalks, walkways, driveways or coal chutes, or where subject to contact with awnings, shutters, swinging signs, or similar objects, shall be protected in

any of the following ways: (1) by rigid metal conduit; (2) by intermediate metal conduit; (3) by rigid nonmetallic conduit suitable for the location; (4) by electrical metallic tubing; or (5) by other approved means.

**(b) Other than Service-Entrance Cable.** Individual open conductors and cables other than service-entrance cables shall not be installed within 10 feet (3.05 m) of grade level or where exposed to physical damage.

*Exception: Type MI and Type MC cable shall be permitted within 10 feet (3.05 m) of grade level where not exposed to physical damage or where protected in accordance with Section 300-5(d).*

**230-51. Mounting Supports.** Cables or individual open service conductors shall be supported as specified in (a) or (b) below.

**(a) Service-Entrance Cables.** Service-entrance cables shall be supported by straps or other approved means within 12 inches (305 mm) of every service head, gooseneck, or connection to a raceway or enclosure and at intervals not exceeding 30 inches (762 mm).

**(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 15 feet (4.57 m) and in a manner that will maintain a clearance of not less than 2 inches (50.8 mm) from the surface over which they pass.

**230-53. Raceways to Drain.** Where exposed to the weather, raceways enclosing service-entrance conductors shall be raintight and arranged to drain. Where embedded in masonry, raceways shall be arranged to drain.

*Exception: As permitted in Section 350-2.*

**230-54. Connections at Service Head.**

**(a) Raintight Service Head.** Service raceways shall be equipped with a raintight service head at the point of connection to service-drop conductors.

**(b) Service Cable Equipped with Raintight Service Head or Gooseneck.** Service cables, either (1) unless continuous from pole to service equipment or meter, shall be equipped with a raintight service head, or (2) formed in a gooseneck and taped and painted or taped with a self-sealing, weather-resistant thermoplastic.

**(c) Service Heads Above Service-Drop Attachment.** Service heads and goosenecks in service-entrance cables shall be located above the point of attachment of the service-drop conductors to the building or other structure.

*Exception: Where it is impracticable to locate the service head above the point of attachment, the service head location shall be permitted not farther than 24 inches (610 mm) from the point of attachment.*

**(d) Secured.** Service cables shall be held securely in place.

**(e) Opposite Polarity Through Separately Bushed Holes.** Service heads shall have conductors of opposite polarity brought out through separately bushed holes.

**(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 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-drop conductors and service-entrance conductors shall be arranged so that water will not enter service raceway or equipment.

**230-55. Termination at Service Equipment.** Any service raceway or cable shall terminate at the inner end in a box, cabinet, or equivalent fitting that effectively encloses all energized metal parts.

### E. Service Equipment — General

**230-62. Service Equipment — Enclosed or Guarded.** Energized parts of service equipment shall be enclosed as specified in (a) below, or guarded as specified in (b) below.

**(a) Enclosed.** Energized parts shall be enclosed so that they will not be exposed to accidental contact or guarded as in (b) below.

**(b) Guarded.** Energized parts that are not enclosed shall be installed on a switchboard, panelboard, or control board and guarded in accordance with Sections 110-17 and 110-18. Such an enclosure shall be provided with means for locking or sealing doors providing access to energized parts.

**230-63. Grounding and Bonding.** Service equipment, raceways, cable armor, cable sheaths, etc., and any service conductor that is to be grounded shall be grounded in accordance with the following parts of Article 250.

Part B. Circuit and System Grounding.

Part C. Location of System Grounding Connections.

Part D. Enclosure Grounding.

Part F. Methods of Grounding.

Part G. Bonding.

Part H. Grounding Electrode Systems.

Part J. Grounding Conductors.

**230-64. Working Space.** Sufficient working space shall be provided in the vicinity of the service equipment to permit safe operation, inspection, and repairs. In no case shall this be less than that specified by Section 110-16.

### F. Service Equipment — Disconnecting Means

**230-70. General.** Means shall be provided to disconnect all conductors in a building or other structure from the service-entrance conductors.

**(a) 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.

**(b) Marking.** Each service disconnecting means shall be permanently marked to identify it as a service disconnecting means.

**(c) Suitable For Use.** Each service disconnecting means shall be suitable for the prevailing conditions.

### 230-71. Maximum Number of Disconnects.

**(a) General.** The service disconnecting means for each service permitted by Section 230-2, or for each set of service-entrance conductors permitted by Section 230-40, Exception No. 1, 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. There shall be no more than six disconnects per service grouped in any one location.

**(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 "handle ties" or a "master handle" to disconnect all conductors of the service with no more than six operations of the hand.

(FPN): See Section 384-16(a) for service equipment in panelboards.

### 230-72. Grouping of Disconnects.

**(a) General.** The two to six disconnects as permitted in Section 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 Section 230-71, when used only for a water pump also intended to provide fire protection, shall be permitted to be located remote from the other disconnecting means.*

**(c) Access to Occupants.** In a multiple-occupancy building, each occupant shall have access to the occupant's service disconnecting means.

**230-74. Simultaneous Opening of Poles.** Each service disconnecting means shall simultaneously disconnect all ungrounded service conductors 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.

**230-76. Manually or Power Operable.** The service disconnecting means for ungrounded service conductors shall consist of either (1) a manually operable switch or circuit breaker equipped with a handle or other suitable operating means, or (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 or closed position.

**230-78. Externally Operable.** An enclosed service disconnecting means shall be externally operable without exposing the operator to contact with energized parts.

*Exception: A power-operated switch or circuit breaker shall not be required to be externally operable by hand to a closed position.*

**230-79. Rating of Disconnect.** The service disconnecting means shall have a rating not less than the load to be carried, determined in accordance with Article 220. In no case shall the rating be lower than specified in (c) or (d) below.

**(c) One-Family Dwelling.** For a one-family dwelling, the service disconnecting means shall have a rating of not less than 100 amperes, 3-wire under either of the following conditions: (1) where the initial computed load is 10 kVA or more, or (2) where the initial installation consists of six or more 2-wire branch circuits.

**(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 Section 230-71, the combined ratings of all the switches or circuit breakers used shall not be less than the rating required for a single switch or circuit breaker.

**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 upon solder shall not be used.

**230-82. Equipment Connected to the Supply Side of Service Disconnect.** Equipment shall not be connected to the supply side of the service disconnecting means.

*Exception No. 1: Cable limiters or other current-limiting devices.*

*Exception No. 2: Fuses and disconnecting means or circuit breakers suitable for use as service equipment, in meter pedestals or otherwise provided and connected in series with the ungrounded service conductors and located away from the building supplied.*

*Exception No. 3: Meters nominally rated not in excess of 600 volts, provided all metal housings and service enclosures are grounded in accordance with Article 250.*

*Exception No. 5: Taps used only to supply load management devices, circuits for emergency systems, stand-by 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.*

**230-84. More than One Building or Other Structure.**

**(a) Disconnect Required for Each.** Where more than one building or other structure is on the same property and under single management, each building or other structure served shall be provided with means for disconnecting all ungrounded conductors.

Location shall be in accordance with Section 230-70.

**(b) Suitable for Service Equipment.** The disconnecting means specified in (a) above shall be suitable for use as service equipment.

*Exception: For garages and outbuildings on residential property, a snap switch or a set of 3-way or 4-way snap switches suitable for use on branch circuits shall be permitted as the disconnecting means.*

### G. Service Equipment — Overcurrent Protection

**230-90. Where Required.** Each ungrounded service conductor shall have overload protection.

**(a) Ungrounded Conductor.** Such protection shall be provided by an overcurrent device in series with each ungrounded service conductor having a rating or setting not higher than the allowable ampacity of the conductor.

*Exception No. 1: For motor-starting currents, ratings in conformity with Sections 430-52, 430-62, and 430-63 in the NEC shall be permitted.*

*Exception No. 2: Fuses and circuit breakers with a rating or setting in conformity with Section 240-3, Exception No. 4, and Section 240-6 in the NEC.*

*Exception No. 3: Not more than six circuit breakers or six sets of fuses shall be considered as the overcurrent device.*

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 Section 230-71(b), shall be considered as one protective device.

**(b) Not in Grounded Conductor.** No overcurrent device shall be inserted in a grounded service conductor except a circuit breaker which simultaneously opens all conductors of the circuit.

**230-91. Location of Overcurrent Protection.**

**(a) General.** The service overcurrent device shall be an integral part of the service disconnecting means or shall be located immediately adjacent thereto.

**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. 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, provided all metal housings and service enclosures are grounded in accordance with Article 250.*

# ARTICLE 240 — OVERCURRENT PROTECTION

**240-1. Scope.** Parts A through G of this article provide the general requirements for overcurrent protection and overcurrent protective devices not more than 600 volts, nominal.

(FPN): 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. See also Sections 110-9 and 110-10 for requirements for interrupting capacity and protection against fault currents.

## A. General

**240-2. Protection of Equipment.** Equipment shall be protected against overcurrent in accordance with the article in this Code covering the type of equipment as specified in the following list.

| | Article |
|---|---|
| Appliances | 422 |
| Class 1, Class 2, and Class 3 Remote-Control, Signaling, and Power-Limited Circuits | 725 |
| Closed-Loop and Programmed Power Distribution | 780 |
| Fixed Electric Space Heating Equipment | 424 |
| Services | 230 |

**240-3. Protection of Conductors — Other than Flexible Cords and Fixture Wires.** Conductors, other than flexible cords and fixture wires, shall be protected against overcurrent in accordance with their ampacities as specified in Table 310-16 and all applicable notes to this table.

*Exception No. 1: Remote Control Circuits. Remote control circuits shall comply with Article 725 in the NEC.*

*Exception No. 4: Next Higher Overcurrent Protective Device Rating. Where the ampacity of the conductor does not correspond with the standard ampere rating of a fuse or a circuit breaker without overload trip adjustment above its rating (but which may have other trip or rating adjustments), the next higher standard device rating shall be permitted only if this rating does not exceed 800 amperes and the conductor is not part of a multioutlet branch circuit supplying receptacles for cord- and plug-connected portable loads.*

**240-8. Fuses or Circuit Breakers in Parallel.** Fuses, circuit breakers, or combinations thereof shall not be connected in parallel.

*Exception: Circuit breakers or fuses, factory assembled in parallel, and approved as a unit.*

## B. Location

**240-20. 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.

(FPN): For motor circuits, see Parts C, D, F, and J of Article 430 in the NEC.

**(b) Circuit Breaker as Overcurrent Device.** Circuit breakers shall open all ungrounded conductors of the circuit.

*Exception: Individual single-pole circuit breakers shall be acceptable as the protection for each ungrounded conductor of single-phase circuits, or for each ungrounded conductor of lighting or appliance branch circuits connected to 4-wire, 3-phase systems, provided such lighting or appliance circuits are supplied from a system having a grounded neutral and no conductor in such circuits operates at a voltage greater than permitted in Section 210-6.*

**(c) Closed-Loop Power Distribution Systems.** Listed devices providing equivalent overcurrent protection in closed-loop power distribution systems shall be permitted as a substitute for fuses or circuit breakers.

**240-22. Grounded Conductors.** No overcurrent device shall be connected in series with any conductor that is intentionally grounded.

*Exception No. 1: Where the overcurrent device opens all conductors of the circuit, including the grounded conductor, and is so designed that no pole can operate independently.*

**240-23. Change in Size of Grounded Conductor.** Where a change occurs in the size of the ungrounded conductor, a similar change shall be permitted to be made in the size of the grounded conductor.

**240-24. Location in or on Premises.**

**(a) Readily Accessible.** Overcurrent devices shall be readily accessible.

**(b) Occupant to Have Ready Access.** Each occupant shall have ready access to all overcurrent devices protecting the conductors supplying that occupancy.

**(c) Not Exposed to Physical Damage.** Overcurrent devices shall be located where they will not be exposed to physical damage.

**(d) Not in Vicinity of Easily Ignitible Material.** Overcurrent devices shall not be located in the vicinity of easily ignitible material such as in clothes closets.

### C. Enclosures

**240-30. General.** Overcurrent devices shall be enclosed in cabinets or cutout boxes.

*Exception No. 1: Where a part of an assembly that provides equivalent protection.*

*Exception No. 3: 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 be identified for use in such locations and shall be mounted so there is at least 1/4-inch (6.35-mm) air space between the enclosure and the wall or other supporting surface.

**240-33. Vertical Position.** Enclosures for overcurrent devices shall be mounted in a vertical position.

*Exception: Where this is shown to be impracticable and complies with Section 240-81 in the NEC.*

### E. Plug Fuses, Fuseholders, and Adapters

**240-50. General.**

**(a) Maximum Voltage.** Plug fuses and fuseholders shall not be used in circuits exceeding 125 volts between conductors.

*Exception: In circuits supplied by a system having a grounded neutral and having no conductor at over 150 volts to ground.*

**(e) Screw Shell.** The screw shell of a plug-type fuseholder shall be connected to the load side of the circuit.

## ARTICLE 250 — GROUNDING

### A. General

**250-1. Scope.** This article covers general requirements for grounding and bonding of electrical installations, and specific requirements in (a) through (f) below.

(a) Systems, circuits, and equipment required, permitted, or not permitted to be grounded.

(b) Circuit conductor to be grounded on grounded systems.

(c) Location of grounding connections.

(d) Types and sizes of grounding and bonding conductors and electrodes.

(e) Methods of grounding and bonding.

(f) Conditions under which guards, isolation, or insulation may be substituted for grounding.

(FPN No. 1): Systems and circuit conductors are grounded to limit voltages due to lightning, line surges, or unintentional contact with higher voltage lines, and to stabilize the voltage to ground during normal operation. Systems and circuit conductors are solidly grounded to facilitate overcurrent device operation in case of ground faults.

(FPN No. 2): Conductive materials enclosing electrical conductors or equipment, or forming part of such equipment, are grounded to limit the voltage to ground on these materials and to facilitate overcurrent device operation in case of ground faults. See Section 110-10.

**250-2. Application of Other Articles.** In other articles applying to particular cases of installation of conductors and equipment, there are requirements that are in addition to those of this article or are modifications of them:

## B. Circuit and System Grounding

**250-5. Alternating-Current Circuits and Systems to Be Grounded.** AC circuits and systems shall be grounded as provided for in (a) or (b) below. Other circuits and systems shall be permitted to be grounded.

**(a) Alternating-Current Circuits of Less than 50 Volts.** AC circuits of less than 50 volts shall be grounded under any of the following conditions:

**(1)** Where supplied by transformers if the transformer supply system exceeds 150 volts to ground.

**(2)** Where supplied by transformers if the transformer supply system is ungrounded.

(3) Where installed as overhead conductors outside of buildings.

**(b) Alternating-Current Systems of 50 Volts to 1000 Volts.** AC systems of 50 volts to 1000 volts supplying premises wiring and premises wiring systems shall be grounded under any of the following conditions:

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

(4) Where a grounded service conductor is uninsulated in accordance with the Exceptions to Sections 230-22, 230-30, and 230-41.

### C. Location of System Grounding Connections

### 250-21. Objectionable Current over Grounding Conductors.

**(a) Arrangement to Prevent Objectionable Current.** The grounding of electric systems, circuit conductors, surge arresters, and conductive noncurrent-carrying materials and equipment shall be installed and arranged in a manner that will prevent an objectionable flow of current over the grounding conductors or grounding paths.

**(b) Alterations to Stop Objectionable Current.** If the use of multiple grounding connections results in an objectionable flow of current, one or more of the following alterations shall be made:

(1) Discontinue one or more such grounding connections.

(2) Change the locations of the grounding connections.

(3) Interrupt the continuity of the conductor or conductive path interconnecting the grounding connections.

(4) Take other suitable remedial action satisfactory to the authority having jurisdiction.

**(c) Temporary Currents Not Classified as Objectionable Currents.** Temporary currents resulting from accidental conditions, such as ground-fault currents, that occur only while the grounding conductors are performing their intended protective functions shall not be classified as objectionable current for the purposes specified in (a) and (b) above.

### 250-23. Grounding Service-Supplied Alternating-Current Systems.

**(a) System Grounding Connections.** A premises wiring system that is supplied by an ac service and is required to be grounded by Section 250-5 shall have at each service a grounding electrode conductor connected to a grounding electrode which complies with Part H of Article 250. The grounding electrode conductor shall be connected to the grounded service conductor at any accessible point from the load end of the service drop or service lateral to and including the terminal or bus to which the grounded service conductor is connected at the service disconnecting means. Where 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. A grounding connection shall not be made to any grounded circuit conductor on the load side of the service disconnecting means.

(FPN): See definition of Service Drop and Service Lateral; also Section 230-21.

*Exception No. 2: A grounding conductor connection shall be made at each separate building where required by Section 250-24.*

*Exception No. 3: For ranges, counter-mounted cooking units, wall-mounted ovens, clothes dryers, and meter enclosures as permitted by Section 250-61.*

**(b) Grounded Conductor Brought to Service Equipment.** Where an ac system operating at less than 1000 volts is grounded at any point, the grounded conductor shall be run to each service disconnecting means and shall be bonded to each disconnecting means enclosure. This conductor shall be routed with the phase conductors and shall not be smaller than the required grounding electrode conductor specified in Table 250-94 and, in addition, for service-entrance phase conductors larger than 1100 kcmil copper or 1750 kcmil aluminum, the grounded conductor shall not be smaller than 12½ percent of the area of the largest service-entrance phase conductor. Where the service-entrance phase conductors are paralleled, the size of the grounded conductor shall be based on the equivalent area for parallel conductors as indicated in this section.

(FPN): See Section 310-4.

*Exception No. 1: The grounded conductor shall not be required to be larger than the largest ungrounded service-entrance phase conductor.*

*Exception No. 3: Where more than one service disconnecting means are located in an assembly listed for use as service equipment, one grounded conductor shall be required to be run to the assembly and it shall be bonded to the assembly enclosure.*

### 250-24. Two or More Buildings or Structures Supplied from a Common Service.

**(a) Grounded Systems.** Where two or more buildings or structures are supplied from a common service, the grounded system in each building or structure shall have a grounding electrode as described in Part H connected to the metal enclosure of the building disconnecting means and to the ac system grounded circuit conductor on the supply side of the building or structure disconnecting means.

*Exception No. 1: A grounding electrode at separate buildings or structures shall not be required where only one branch circuit is supplied and there is no equipment in the building or structure that requires grounding.*

*Exception No. 2: A grounded circuit conductor connection to the grounding electrode shall not be required at a separate building or structure if an equipment grounding conductor is run with the circuit conductors for grounding any noncurrent-carrying equipment, interior metal piping systems and building or structural metal frames and the equipment grounding conductor is bonded at a separate building or structure disconnecting means to existing grounding electrodes described in Part H. Where there are no existing electrodes, a grounding electrode meeting the requirements of Part H shall be installed where the building or structure supplies more than one branch circuit.*

### 250-25. Conductor to Be Grounded — Alternating-Current Systems.

For ac premises wiring systems, the conductor to be grounded shall be as specified in (1) through (5) below.

(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 common conductor.

(4) Multiphase systems requiring one grounded phase: one phase conductor.

(5) Multiphase systems in which one phase is used as in (2) above: the neutral conductor.

Grounded conductors shall be identified by the means specified in Article 200.

### D. Enclosure Grounding

**250-32. Service Raceways and Enclosures.** Metal enclosures for service conductors and equipment shall be grounded.

**250-33. Other Conductor Enclosures.** Metal enclosures for other than service conductors shall be grounded.

*Exception No. 1: Metal enclosures for conductors added to existing installations of open wire, knob-and-tube wiring, and nonmetallic-sheathed cable, which do not provide an equipment ground, if in runs of less than 25 feet (7.62 m), if free from probable contact with ground, grounded metal, metal lath, or other conductive material, and if guarded against contact by persons shall not be required to be grounded.*

*Exception No. 2: Short sections of metal enclosures used to provide support or protection of cable assemblies from physical damage shall not be required to be grounded.*

*Exception No. 3: Enclosures not required to be grounded by Section 250-43(i) shall not be required to be grounded.*

### E. Equipment Grounding

**250-42. Equipment Fastened in Place or Connected by Permanent Wiring Methods (Fixed).** Exposed noncurrent-carrying metal parts of fixed equipment likely to become energized shall be grounded under any of the conditions in (a) through (f) below.

**(a) Vertical and Horizontal Distances.** Where within 8 feet (2.44 m) vertically or 5 feet (1.52 m) horizontally of ground or grounded metal objects and subject to contact by persons.

**(b) Wet or Damp Locations.** Where located in a wet or damp location and not isolated.

**(c) Electrical Contact.** Where in electrical contact with metal.

**(e) Wiring Methods.** Where supplied by a metal-clad, metal-sheathed, metal-raceway, or other wiring method which provides an equipment ground, except as permitted by Section 250-33 for short sections of metal enclosures.

**(f) Over 150 Volts to Ground.** Where equipment operates with any terminal at over 150 volts to ground.

*Exception No. 2: Metal frames of electrically heated appliances, exempted by special permission, in which case the frames shall be permanently and effectively insulated from ground.*

**250-43. Fastened in Place or Connected by Permanent Wiring Methods (Fixed) – Specific.** Exposed, noncurrent-carrying metal parts of the kinds of equipment described in (i) and (j) below, regardless of voltage, shall be grounded.

**(i) Remote-Control, Signaling, and Fire Protective Signaling Circuits.** Equipment supplied by Class 1, Class 2, and Class 3 remote-control and signaling circuits, and by fire protective signaling circuits, shall be grounded where system grounding is required by Part B of this article.

**(j) Lighting Fixtures.** Lighting fixtures as provided in Part E of Article 410.

**250-44. Nonelectric Equipment.**

(FPN): Where extensive metal in or on buildings may become energized and is subject to personal contact, adequate bonding and grounding will provide additional safety.

**250-45. Equipment Connected by Cord and Plug.** Under any of the conditions described in (c) below, exposed noncurrent-carrying metal parts of cord- and plug-connected equipment likely to become energized shall be grounded.

**(c) In Residential Occupancies.** In residential occupancies: (1) refrigerators, freezers, and air conditioners; (2) clothes-washing, clothes-drying, dish-washing machines, sump pumps, electrical aquarium equipment; (3) hand-held motor-operated tools; (4) motor-operated appliances of the following types: hedge clippers, lawn mowers, snow blowers, and wet scrubbers; (5) portable handlamps.

*Exception: Listed tools and listed appliances protected by a system of double insulation, or its equivalent, shall not be required to be grounded. Where such a system is employed, the equipment shall be distinctively marked.*

## F. Methods of Grounding

**250-50. Equipment Grounding Conductor Connections.** Equipment grounding conductor connections at the source of separately derived systems shall be made in accordance with Section 250-26(a) in the NEC. Equipment grounding conductor connections at service equipment shall be made as indicated in (a) below.

**(a) For Grounded System.** The connection shall be made by bonding the equipment grounding conductor to the grounded service conductor and the grounding electrode conductor.

*Exception: For replacement of nongrounding-type receptacles with grounding-type receptacles and for branch-circuit extensions only in existing installations that do not have an equipment grounding conductor in the branch circuit, the grounding conductor of a grounding-type receptacle outlet shall be permitted to be grounded to a water pipe which is bonded in accordance with Section 250-80(a).*

(FPN): See Section 210-7(d), Exception, for the use of a ground-fault circuit-interrupter type of receptacle.

**250-51. Effective Grounding Path.** The path to ground from circuits, equipment, and metal enclosures for conductors shall: (1) be permanent and continuous; (2) have capacity to conduct safely any fault current likely to be imposed on it; and (3) have sufficiently low impedance to limit the voltage to ground and to facilitate the operation of the circuit protective devices in the circuit.

The earth shall not be used as the sole equipment grounding conductor.

**250-53. Grounding Path to Grounding Electrode at Services.**

**(a) Grounding Electrode Conductor.** A grounding electrode conductor shall be used to connect the equipment grounding conductors, the service-equipment enclosures and, where the system is grounded, the grounded service conductor to the grounding electrode.

(FPN): See Section 250-23(a).

**(b) Main Bonding Jumper.** For a grounded system, an unspliced main bonding jumper shall be used to connect the equipment grounding conductor and the service-equipment enclosure to the grounded conductor of the system within the service equipment or within the service conductor enclosure.

**250-54. Common Grounding Electrode.** Where an ac system is connected to a grounding electrode in or at a building as specified in Sections 250-23 and 250-24, the same electrode shall be used to ground conductor enclosures and equipment in or on that building. Where separate services supply a building and are required to be connected to a grounding electrode, the same grounding electrode shall be used.

Two or more grounding electrodes that are effectively bonded together shall be considered as a single grounding electrode system in this sense.

**250-55. Underground Service Cable.** Where served from a continuous underground metal-sheathed cable system, the sheath or armor of underground service cable metallically connected to the underground system, or underground service conduit containing a metal-sheathed cable bonded to the underground system, shall not be required to be grounded at the building and shall be permitted to be insulated from the interior conduit or piping.

**250-56. Short Sections of Raceway.** Isolated sections of metal raceway or cable armor, where required to be grounded, shall be grounded in accordance with Section 250-57.

**250-57. Equipment Fastened in Place or Connected by Permanent Wiring Methods (Fixed) — Grounding.** Noncurrent-carrying metal parts of equipment, raceways, and other enclosures, where required to be grounded, shall be grounded by one of the methods indicated in (a) or (b) below.

*Exception: Where equipment, raceways, and enclosures are grounded by connection to the grounded circuit conductor as permitted by Sections 250-24, 250-60, and 250-61.*

**(a) Equipment Grounding Conductor Types.** By any of the equipment grounding conductors permitted by Section 250-91(b).

**(b) With Circuit Conductors.** By an equipment grounding conductor contained within the same raceway, cable, or cord or otherwise run with the circuit conductors. Bare, covered or insulated equipment grounding conductors shall be permitted. Individually covered or insulated equipment grounding conductors shall have a continuous outer finish that is either green, or green with one or more yellow stripes.

*Exception No. 1: An insulated or covered conductor larger than No. 6 copper or aluminum shall, at the time of installation, be permitted to be permanently identified as an equipment grounding conductor at each end and at every point where the conductor is accessible. Identification shall be accomplished by one of the following:*

*a. Stripping the insulation or covering from the entire exposed length,*

*b. Coloring the exposed insulation or covering green, or*

*c. Marking the exposed insulation or covering with green colored tape or green colored adhesive labels.*

(FPN): See Section 400-7 for use of cords for fixed equipment.

**250-58. Equipment Considered Effectively Grounded.** Under the conditions specified in (a) and (b) below, the noncurrent-carrying metal parts of the equipment shall be considered effectively grounded.

**(a) Equipment Secured to Grounded Metal Supports.** Electric equipment secured to and in electrical contact with a metal rack or structure provided for its support and grounded by one of the means indicated in Section 250-57. The structural metal frame of a building shall not be used as the required equipment grounding conductor for ac equipment.

**250-59. Cord- and Plug-Connected Equipment.** Noncurrent-carrying metal parts of cord- and plug-connected equipment, where required to be grounded, shall be grounded by one of the methods indicated in (a), (b), or (c) below.

**(a) By Means of the Metal Enclosure.** By means of the metal enclosure of the conductors supplying such equipment if a grounding-type attachment plug with one fixed grounding contact is used for grounding the metal enclosure, and if the metal enclosure of the conductors is secured to the attachment plug and to equipment by approved connectors.

**(b) By Means of a 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 grounding-type attachment plug with one fixed grounding contact. An uninsulated equipment grounding conductor shall be permitted but, if individually covered, the covering shall have a continuous outer finish that is either green or green with one or more yellow stripes.

*Exception: A self-restoring grounding contact shall be permitted on grounding-type attachment plugs used on the power supply cord of portable hand-held, hand-guided, or hand-supported tools or appliances.*

**(c) Separate Flexible Wire or Strap.** By means of a separate flexible wire or strap, insulated or bare, protected as well as practicable against physical damage, where part of equipment.

**250-60. Frames of Ranges and Clothes Dryers.** Frames of electric ranges, wall-mounted ovens, counter-mounted cooking units, clothes dryers, and outlet or junction boxes which are part of the circuit for these appliances shall be grounded in the manner specified by Section 250-57 or 250-59; or, except for mobile homes and recreational vehicles, shall be permitted to be grounded to the grounded circuit conductor if all of the conditions indicated in (a) through (d) below are met.

**(a)** 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.

**(b)** The grounded conductor is not smaller than No, 10 copper or No. 8 aluminum.

**(c)** 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.

**(d)** Grounding contacts of receptacles furnished as part of the equipment are bonded to the equipment.

**250-61. Use of Grounded Circuit Conductor for Grounding Equipment.**

**(a) Supply-Side Equipment.** A grounded circuit conductor shall be permitted to ground noncurrent-carrying metal parts of equipment, raceways, and other enclosures at any of the following locations:

**(1)** On the supply side of the service disconnecting means.

**(2)** On the supply side of the main disconnecting means for separate buildings as provided in Section 250-24.

**(3)** On the supply side of the disconnecting means or overcurrent devices of a separately derived system.

**(b) Load-Side Equipment.** A grounded circuit conductor shall not be used for grounding noncurrent-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 specified by Section 250-60.*

*Exception No. 2: As permitted in Section 250-24 for separate buildings.*

## G. Bonding

**250-70. General.** Bonding shall be provided where necessary to assure electrical continuity and the capacity to conduct safely any fault current likely to be imposed.

**250-71. Service Equipment.**

**(a) Bonding of Service Equipment.** The noncurrent-carrying metal parts of equipment indicated in (1), (2) and (3) below shall be effectively bonded together.

(1) Except as permitted in Section 250-55, the service raceways, cable trays, or service cable armor or sheath.

(2) All service equipment enclosures containing service conductors, including meter fittings, boxes, or the like, interposed in the service raceway or armor.

(3) Any metallic raceway or armor enclosing a grounding electrode conductor as permitted in Section 250-92(a).

**(b) Bonding to Other Systems.** An accessible means external to enclosures for connecting intersystem bonding and grounding conductors shall be provided at the service by at least one of the following means:

(1) Exposed metallic service raceways.

(2) Exposed grounding electrode conductor.

(3) Approved means for the external connection of a bonding, or grounding conductor to the service raceway or equipment.

(FPN No. 1): A No. 6 copper conductor with one end bonded to the service raceway or equipment and with 6 inches (152 mm) or more of the other end made accessible on the outside wall is an example of the approved means covered in (b)(3).

(FPN No. 2): See Sections 800-40 and 820-40 in the NEC for bonding and grounding requirements for communications and CATV circuits.

**250-72. Method of Bonding Service Equipment.** Electrical continuity at service equipment shall be assured by one of the methods specified in (a) through (e) below.

**(a) Grounded Service Conductor.** Bonding equipment to the grounded service conductor in a manner provided in Section 250-113.

**(b) Threaded Couplings.** Threaded couplings and threaded bosses on enclosures with joints shall be made up wrenchtight where rigid metal conduit and intermediate metal conduit are involved.

**(c) Threadless Couplings and Connectors.** Threadless couplings and connectors made up tight for rigid metal conduit, intermediate metal conduit and electrical metallic tubing. Standard locknuts or bushings shall not be used for the bonding required by this section.

**(d) Bonding Jumpers.** Bonding jumpers meeting the other requirements of this article shall be used around concentric or eccentric knockouts that are punched or otherwise formed so as to impair the electrical connection to ground.

**(e) Other Devices.** Other approved devices, such as bonding-type locknuts and bushings.

**250-73. Metal Armor or Tape of Service Cable.** The metal covering of service cable having an uninsulated grounded service conductor in continuous electrical contact with its metallic armor or tape shall be considered to be grounded.

**250-74. Connecting Receptacle Grounding Terminal to Box.** An equipment bonding jumper shall be used to connect the grounding terminal of a grounding-type receptacle to a grounded box.

*Exception No. 1: Where the box is surface mounted, direct metal-to-metal contact between the device yoke and the box shall be permitted to ground the receptacle to the box. This Exception shall not apply to cover-mounted receptacles unless the box and cover combination are listed as providing satisfactory ground continuity between the box and the receptacle.*

*Exception No. 2: Contact devices or yokes designed and listed for the purpose shall be permitted in conjunction with the supporting screws to establish the grounding circuit between the device yoke and flush-type boxes.*

*Exception No. 3: Floor boxes designed for and listed as providing satisfactory ground continuity between the box and the device.*

**250-75. Bonding Other Enclosures.** Metal raceways, cable armor, cable sheath, enclosures, frames, fittings, and other metal noncurrent-carrying parts that are to serve as grounding conductors with or without the use of supplementary equipment grounding conductors shall be effectively bonded where necessary to assure electrical continuity and the capacity to conduct safely any fault current likely to be imposed on them. Any nonconductive paint, enamel, or similar coating shall be removed at threads, contact points, and contact surfaces or be connected by means of fittings so designed as to make such removal unnecessary.

**250-79. Main and Equipment Bonding Jumpers.**

**(a) Material.** Main and equipment bonding jumpers shall be of copper or other corrosion-resistant material. A main bonding jumper shall be a wire, bus, screw, or similar suitable conductor.

**(b) Construction.** Where a main bonding jumper is a screw, the screw shall be identified with a green finish that shall be visible with the screw installed.

**(c) Attachment.** Main and equipment bonding jumpers shall be attached in the manner specified by the applicable provisions of Section 250-113 for circuits and equipment and by Section 250-115 for grounding electrodes.

**(d) Size – Equipment Bonding Jumper on Supply Side of Service and Main Bonding Jumper.** The bonding jumper shall not be smaller than the sizes given in Table 250-94 for grounding electrode conductors.

**(e) Size – Equipment Bonding Jumper on Load Side of Service.** The equipment bonding jumper on the load side of the service overcurrent devices shall not be smaller than the sizes listed by Table 250-95 for equipment grounding conductors. A single common continuous equipment bonding jumper shall be permitted to bond two or more raceways or cables where the bonding jumper is sized in accordance with Table 250-95 for the largest overcurrent device supplying circuits therein.

*Exception: The equipment bonding jumper shall not be required to be larger than the circuit conductors supplying the equipment, but shall not be smaller than No. 14 AWG.*

**(f) Installation — Equipment Bonding Jumper.** The equipment bonding jumper shall be permitted to be installed inside or outside of a raceway or enclosure. Where installed on the outside, the length of the equipment bonding jumper shall not exceed 6 feet (1.83 m) and shall be routed with the raceway or enclosure. Where installed inside of a raceway, the equipment bonding jumper shall comply with the requirements of Sections 250-114 and 310-12(b).

**250-80. Bonding of Piping Systems.**

**(a) Metal Water Piping.** The interior metal water piping system shall be bonded to the service equipment enclosure, the grounded conductor at the service, the grounding electrode conductor where of sufficient size, or to the one or more grounding electrodes used. The bonding jumper shall be sized in accordance with Table 250-94 and installed in accordance with Section 250-92(a) and (b). The points of attachment of the bonding jumper shall be accessible.

*Exception: In two-family dwellings, where the interior metal water piping system for the individual occupancies is metallically isolated from all other occupancies by use of nonmetallic water piping, the interior metal water piping system for each occupancy shall be permitted to be bonded to the panelboard or switchboard enclosure (other than service equipment) supplying that occupancy. The bonding jumper shall be sized in accordance with Table 250-95.*

**(b) Other Metal Piping.** Interior metal piping which may become energized shall be bonded to the service equipment enclosure, the grounded conductor at the service, the grounding electrode conductor where of sufficient size, or to the one or more grounding electrodes used. The bonding jumper shall be sized in accordance with Table 250-95 using the rating of the circuit which may energize the piping.

The equipment grounding conductor for the circuit which may energize the piping shall be permitted to serve as the bonding means.

(FPN): Bonding all piping and metal air ducts within the premises will provide additional safety.

## H. Grounding Electrode System

**250-81. Grounding Electrode System.** If available on the premises at each building or structure served, each item (a) through (d) below, and any made electrodes in accordance with Section 250-83(c) and (d), shall be bonded together to form the grounding electrode system. The bonding jumper shall be installed in accordance with Section 250-92(a), shall be sized in accordance with Section 250-94, and shall be connected in the manner specified in Section 250-115. The unspliced grounding electrode conductor shall be permitted to run to any convenient grounding electrode available in the grounding electrode system. It shall be sized for the largest grounding electrode conductor required among all the available electrodes.

**(a) Metal Underground Water Pipe.** A metal underground water pipe in direct contact with the earth for 10 feet (3.05 m) or more (including any metal well casing effectively bonded to the pipe) and electrically continuous

(or made electrically continuous by bonding around insulating joints or sections or insulating pipe) to the points of connection of the grounding electrode conductor and the bonding conductors. Continuity of the grounding path or the bonding connection to interior piping shall not rely on water meters. A metal underground water pipe shall be supplemented by an additional electrode of a type specified in Section 250-81 or in Section 250-83. The supplemental electrode shall be permitted to be bonded to the grounding electrode conductor, the grounded service-entrance conductor, the grounded service raceway, any grounded service enclosure, or the interior metal water piping at any convenient point.

Where the supplemental electrode is a made electrode as in Section 250-83(c) or (d), that portion of the bonding jumper which is the sole connection to the supplemental grounding electrode shall not be required to be larger than No. 6 copper wire or No. 4 aluminum wire.

**(b) Metal Frame of the Building.** The metal frame of the building, where effectively grounded.

(FPN): Effectively grounded means intentionally connected to earth through a ground connection or connections of sufficiently low impedance and having sufficient current-carrying capacity to prevent the buildup of voltages which may result in undue hazard to connected equipment or to persons.

**(c) Concrete-Encased Electrode.** An electrode encased by at least 2 inches (50.8 mm) of concrete, located within and near the bottom of a concrete foundation or footing that is in direct contact with the earth, consisting of at least 20 feet (6.1 m) of one or more steel reinforcing bars or rods of not less than $\frac{1}{2}$ inch (12.7 mm) diameter, or consisting of at least 20 feet (6.1 m) of bare copper conductor not smaller than No. 4 AWG.

**(d) Ground Ring.** A ground ring encircling the building or structure, in direct contact with the earth at a depth below earth surface not less than $2\frac{1}{2}$ feet (762 mm), consisting of at least 20 feet (6.1 m) of bare copper conductor not smaller than No. 2 AWG.

**250-83. Made and Other Electrodes.** Where none of the electrodes specified in Section 250-81 is available, one or more of the electrodes specified in (b) through (d) below shall be used. Where practicable, made electrodes shall be embedded below permanent moisture level. Made electrodes shall be free from nonconductive coatings, such as paint or enamel. Where more than one electrode is used, each electrode of one grounding system (including that used for lightning rods) shall not be less than 6 feet (1.83 m) from any other electrode of another grounding system.

(FPN): Two or more electrodes that are effectively bonded together are to be treated as a single electrode system in this sense.

**(a) Metal Underground Gas Piping System.** A metal underground gas piping system shall not be used as a grounding electrode.

**(b) Other Local Metal Underground Systems or Structures.** Other local metal underground systems or structures, such as piping systems and underground tanks.

**(c) Rod and Pipe Electrodes.** Rod and pipe electrodes shall not be less than 8 feet (2.44 m) in length and shall consist of the following materials, and shall be installed in the following manner:

(1) Electrodes of pipe or conduit shall not be smaller than 3/4-inch trade size and, where of iron or steel, shall have the outer surface galvanized or otherwise metal-coated for corrosion protection.

(2) Electrodes of rods of iron or steel shall be at least 5/8 inch (15.87 mm) in diameter. Nonferrous or stainless steel rods or their equivalent less than 5/8 inch (15.87 mm) in diameter shall be listed and shall not be less than 1/2 inch (12.7 mm) in diameter.

(3) The electrode shall be installed such that at least 8 feet (2.44 m) of length is in contact with the soil. It shall be driven to a depth of not less than 8 feet (2.44 m) 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 shall be buried in a trench that is at least 2 1/2 feet (762 mm) 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 Section 250-117.

**(d) Plate Electrodes.** Each plate electrode shall expose not less than 2 square feet (0.186 sq m) of surface to exterior soil. Electrodes of iron or steel plates shall be at least 1/4 inch (6.35 mm) in thickness. Electrodes of nonferrous metal shall be at least 0.06 inch (1.52 mm) in thickness.

**(e) Aluminum Electrodes.** Aluminum electrodes shall not be permitted.

**250-84. Resistance of Made Electrodes.** A single electrode consisting of a rod, pipe, or plate which does not have a resistance to ground of 25 ohms or less shall be augmented by one additional electrode of any of the types specified in Sections 250-81 or 250-83. Where multiple rod, pipe, or plate electrodes are installed to meet the requirements of this section, they shall be not less than 6 feet (1.83 m) apart.

(FPN): The paralleling efficiency of rods longer than 8 feet (2.44 m) is improved by spacing greater than 6 feet (1.83 m).

**250-86. Use of Lightning Rods.** Lightning rod conductors and driven pipes, rods, or other made electrodes used for grounding lightning rods shall not be used in lieu of the made grounding electrodes required by Section 250-83 for grounding wiring systems and equipment. This provision shall not prohibit the required bonding together of grounding electrodes of different systems.

(FPN No. 1): See Sections 250-46, 800-40(d), and 820-40(d) in the NEC.

(FPN No. 2): Bonding together of all separate grounding electrodes will limit potential differences between them and between their associated wiring systems.

### J. Grounding Conductors

**250-91. Material.** The material for grounding conductors shall be as specified in (a), (b), and (c) below.

**(a) Grounding Electrode Conductor.** The grounding electrode conductor shall be of copper, aluminum, or copper-clad aluminum. The material selected shall be resistant to any corrosive condition existing at the

installation or shall be suitably protected against corrosion. The conductor shall be solid or stranded, insulated, covered, or bare and shall be installed in one continuous length without a splice or joint.

*Exception No. 2: Where a service consists of more than a single enclosure as permitted in Section 230-40, Exception No. 2, it shall be permissible to connect taps to the grounding electrode conductor. Each such tap conductor shall extend to the inside of each such enclosure. The grounding electrode conductor shall be sized in accordance with Section 250-94, but the tap conductors shall be permitted to be sized in accordance with the grounding electrode conductors specified in Section 250-94 for the largest conductor serving the respective enclosures. The tap conductors shall be connected to the grounding electrode conductor in such a manner that the grounding electrode conductor remains without a splice or joint.*

**(b) Types of Equipment Grounding Conductors.** The equipment grounding conductor run with or enclosing the circuit conductors shall be one or more or a combination of the following: (1) a copper or other corrosion-resistant 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) flexible metal conduit where both the conduit and fittings are listed for grounding; (6) armor of Type AC cable; (11) other electrically continuous metal raceways listed for grounding.

*Exception No. 1: Flexible metal conduit and flexible metallic tubing shall be permitted for grounding if all the following conditions are met:*

*a. The length in any ground return path does not exceed 6 feet (1.83 m).*

*b. The circuit conductors contained therein are protected by overcurrent devices rated at 20 amperes or less.*

*c. The conduit or tubing is terminated in fittings listed for grounding.*

*Exception No. 2: Liquidtight flexible metal conduit shall be permitted as a grounding means in the 1 1/4-inch and smaller trade sizes if the total length of any ground return path is 6 feet (1.83 m) or less, the conduit is terminated in fittings listed for grounding, and the circuit conductors contained therein are protected by overcurrent devices rated at 20 amperes or less for 3/8-inch and 1/2-inch trade sizes and 60 amperes or less for 3/4-inch through 1 1/4-inch trade sizes.*

**(c) Supplementary Grounding.** Supplementary grounding electrodes shall be permitted to augment the equipment grounding conductors specified in Section 250-91(b), but the earth shall not be used as the sole equipment grounding conductor.

**250-92. Installation.** Grounding conductors shall be installed as specified in (a), (b), and (c) below.

**(a) Grounding Electrode Conductor.** A grounding electrode conductor or its enclosure shall be securely fastened to the surface on which it is carried. A No. 4, copper or aluminum, or larger conductor shall be protected if exposed to severe physical damage. A No. 6 grounding conductor that is free from exposure to physical damage shall be permitted to be run along the surface of the building construction without metal covering or

protection where it is securely fastened to the construction; otherwise, it shall be in rigid metal conduit, intermediate metal conduit, rigid nonmetallic conduit, electrical metallic tubing, or cable armor. Grounding conductors smaller than No. 6 shall be in rigid metal conduit, intermediate metal conduit, rigid nonmetallic conduit, electrical metallic tubing, or cable armor.

Aluminum or copper-clad aluminum grounding conductors shall not be used where in direct contact with masonry or the earth or where subject to corrosive conditions. Where used outside, aluminum or copper-clad aluminum grounding conductors shall not be installed within 18 inches (457 mm) of the earth.

**(b) Enclosures for Grounding Electrode Conductors.** Metal enclosures for grounding 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. Metal enclosures that are not physically continuous from cabinet or equipment to the grounding electrode shall be made electrically continuous by bonding each end to the grounding conductor. Where a raceway is used as protection for a grounding conductor, the installation shall comply with the requirements of the appropriate raceway article.

**(c) Equipment Grounding Conductor.** An equipment grounding conductor shall be installed as follows.

**(1)** Where it consists of a raceway, cable tray, cable armor, or cable sheath or where 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 raceway or cable used. All connections, joints, and fittings shall be made tight using suitable tools.

**(2)** Where it is a separate equipment grounding conductor as provided in the Exception for Sections 250-50(a) and (b), it shall be installed in accordance with (a) above in regard to restrictions for aluminum and also in regard to protection from physical damage.

*Exception: Sizes smaller than No. 6 shall not be required to be enclosed in a raceway or armor where run in the hollow spaces of a wall or partition or where otherwise installed so as not to be subject to physical damage.*

**250-94. Size of Alternating-Current Grounding Electrode Conductor.** The size of the grounding electrode conductor of a grounded or ungrounded ac system shall not be less than given in Table 250-94.

*Exception No. 1: Grounded Systems.*

*a. Where connected to made electrodes as in Section 250-83 (c) or (d), that portion of the grounding electrode conductor which is the sole connection to the grounding electrode shall not be required to be larger than No. 6 copper wire or No. 4 aluminum wire.*

*b. Where connected to a concrete-encased electrode as in Section 250-81(c), that portion of the grounding electrode conductor which is the sole connection to the grounding electrode shall not be required to be larger than No. 4 copper wire.*

*c. Where connected to a ground ring as in Section 250-81(d), that portion of the grounding electrode conductor which is the sole connection to the grounding electrode shall not be required to be larger than the conductor used for the ground ring.*

**Table 250-94.**
**Grounding Electrode Conductor for AC Systems**

| Size of Largest Service-Entrance Conductor or Equivalent Area for Parallel Conductors | | Size of Grounding Electrode Conductor | |
|---|---|---|---|
| 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 kcmil | 4 | 2 |

Where multiple sets of service-entrance conductors are used as permitted in Section 230-40, Exception No. 2, 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.

Where 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.

* See installation restrictions in Section 250-92(a).

(FPN): See Section 250-23(b).

**250-95. Size of Equipment Grounding Conductors.** The size of copper, aluminum, or copper-clad aluminum equipment grounding conductors shall not be less than given in Table 250-95.

When conductors are adjusted in size to compensate for voltage drop, equipment grounding conductors, where required, shall be adjusted proportionately according to circular mil area.

Where a single equipment grounding conductor is run with multiple circuits in the same raceway, it shall be sized for the largest overcurrent device protecting conductors in the raceway.

*Exception No. 1: An equipment grounding conductor not smaller than No. 18 copper and not smaller than the circuit conductors and part of fixture wires or cords in accordance with Section 240-4 in the NEC.*

*Exception No. 2: The equipment grounding conductor shall not be required to be larger than the circuit conductors supplying the equipment.*

*Exception No. 3: Where a raceway or a cable armor or sheath is used as the equipment grounding conductor, as provided in Sections 250-57(a) and 250-91(b).*

**Table 250-95. 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 | |
|---|---|---|
| | Copper Wire No. | Aluminum or Copper-Clad Aluminum Wire No.* |
| 15 | 14 | 12 |
| 20 | 12 | 10 |
| 30 | 10 | 8 |
| 40 | 10 | 8 |
| 60 | 10 | 8 |
| 100 | 8 | 6 |
| 200 | 6 | 4 |

* See installation restrictions in Section 250-92(a).

### 250-99. Equipment Grounding Conductor Continuity.

**(a) Separable Connections.** Separable connections such as those provided in attachment plugs and mating connectors and receptacles shall provide for first-make, last-break of the equipment grounding conductor.

*Exception: Interlocked equipment, plugs, receptacles and connectors which preclude energization without grounding continuity.*

**(b) Switches.** No automatic cutout or switch shall be placed in the equipment grounding conductor of a premises wiring system.

*Exception: Where the opening of the cutout or switch disconnects all sources of energy.*

## K. Grounding Conductor Connections

**250-112. To Grounding Electrode.** The connection of a grounding electrode conductor to a grounding electrode shall be accessible and made in a manner that will assure a permanent and effective ground. Where necessary to assure this for a metal piping system used as a grounding electrode, effective bonding shall be provided around insulated joints and sections and around any equipment that is likely to be disconnected for repairs or replacement. Bonding conductors shall be of sufficient length to permit removal of such equipment while retaining the integrity of the bond.

*Exception: An encased or buried connection to a concrete-encased, driven, or buried grounding electrode shall not be required to be accessible.*

**250-113. To Conductors and Equipment.** Grounding conductors and bonding jumpers shall be connected by exothermic welding, listed pressure connectors, listed clamps, or other listed means. Connection devices or fittings that depend solely on solder shall not be used.

**250-114. Continuity and Attachment of Branch-Circuit Equipment Grounding Conductors to Boxes.** Where more than one equipment grounding conductor enters a box all such conductors shall be spliced or joined within the box or to the box with devices suitable for the use. Connections depending solely on solder shall not be used. Splices shall be made in accordance with Section 110-14(b) except that insulation shall not be required. The arrangement of grounding connections shall be such that the disconnection or the removal of a receptacle, fixture, or other device fed from the box will not interfere with or interrupt the grounding continuity.

**(a) Metal Boxes.** A connection shall be made between the one or more equipment grounding conductors and a metal box by means of a grounding screw which shall be used for no other purpose, or a listed grounding device.

**(b) Nonmetallic Boxes.** One or more equipment grounding conductors brought into a nonmetallic outlet box shall be so arranged that a connection can be made to any fitting or device in that box requiring grounding.

**250-115. Connection to Electrodes.** The grounding conductor shall be connected to the grounding fitting 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 where used on pipe, rod or other buried electrodes shall also be listed for direct soil burial. 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. One of the methods indicated in (a), (b), (c), or (d) below shall be used.

**(a) Bolted Clamp.** A listed bolted clamp of cast bronze or brass, or plain or malleable iron.

**(b) Pipe Fitting, Pipe Plug, etc.** A pipe fitting, pipe plug, or other approved device screwed into a pipe or pipe fitting.

**(c) Sheet-Metal-Strap Type Ground Clamp.** 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.

**(d) Other Means.** An equally substantial approved means.

**250-117. Protection of Attachment.** Ground clamps or other fittings shall be approved for general use without protection or shall be protected from ordinary physical damage as indicated in (a) or (b) below.

**(a) Not Likely to Be Damaged.** Installations where they are not likely to be damaged.

**(b) Protective Covering.** Enclosing in metal, wood, or equivalent protective covering.

**250-118. Clean Surfaces.** Nonconductive coatings (such as paint, lacquer, and enamel) on equipment to be grounded shall be removed from threads and other contact surfaces to assure good electrical continuity.

**250-119. Identification of Wiring Device Terminals.** The terminal for the connection of the equipment grounding conductor shall be identified by: (1) a green-colored, not readily removable terminal screw with a hexagonal head; (2) a green-colored, hexagonal, not readily removable terminal nut; or (3) a green-colored pressure wire connector. If the terminal for the grounding conductor is not visible, the conductor entrance hole shall be marked with the word "green" or otherwise identified by a distinctive green color.

## ARTICLE 280 — SURGE ARRESTERS

Installations shall conform to the requirements of Article 280 of the 1990 *National Electrical Code* (NFPA 70-1990).

## ARTICLE 300 — WIRING METHODS

### A. General Requirements

**300-1. Scope.**

**(a) All Wiring Installations.** This article covers wiring methods for all wiring installations.

*Exception No. 2: Only those sections referenced in Article 725 in the NEC shall apply to Class 1, Class 2, and Class 3 circuits.*

*Exception No. 3: Only those sections referenced in Article 760 in the NEC shall apply to fire protective signaling circuits.*

*Exception No. 5: Only those sections referenced in Article 800 in the NEC shall apply to communications systems.*

*Exception No. 6: Only those sections referenced in Article 810 in the NEC shall apply to radio and television equipment.*

*Exception No. 7: Only those sections referenced in Article 820 in the NEC shall apply to community antenna television and radio distribution systems.*

**(b) Integral Parts of Equipment.** The provisions of this article are not intended to apply to the conductors which form an integral part of equipment, such as motors, controllers, motor control centers, or factory-assembled control equipment.

**300-2. Limitations.**

**(a) Voltage.** Wiring methods specified in Chapter 3 shall be used for voltages 600 volts, nominal, or less where not specifically limited in some section of Chapter 3.

**(b) Temperature.** Temperature limitation of conductors shall be in accordance with Section 310-10.

**300-3. Conductors.**

**(a) Single Conductors.** Single conductors specified in Table 310-13 in the NEC shall only be permitted to be installed where part of a recognized wiring method of Chapter 3 in the NEC.

**(b) Conductors of the Same Circuit.** All conductors of the same circuit and, where used, the neutral and all equipment grounding conductors shall be contained within the same raceway, trench, cable, or cord.

*Exception to (a) and (b): As permitted in Sections 250-57(b), 250-79(f), 300-5(i), 300-20(a), and 339-3(a)(2).*

**(c) Conductors of Different Systems.**

**(1) 600 Volts, Nominal, or Less.** Conductors of 600 volts, nominal, or less, alternating current and direct current circuits, 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 nominal circuit voltage rating of any conductor within the enclosure, cable, or raceway.

*Exception: For solar photovoltaic systems in accordance with Section 690-4(b) in the NEC.*

(FPN): See Section 725-38(a)(2) in the NEC for Class 2 and Class 3 circuit conductors.

**300-4. Protection Against Physical Damage.** Where subject to physical damage, conductors shall be adequately protected.

**(a) Cables and Raceways Through Wood Members.**

**(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 1¼ inches (31.8 mm) from the nearest edge 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 or bushing, at least 1/16 inch (1.59 mm) thick, and of appropriate length and width installed to cover the area of the wiring.

*Exception: Raceways as covered in Articles 345, 346, 347, and 348.*

**(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 against nails or screws by a steel plate at least 1/16 inch (1.59 mm) thick installed before the building finish is applied.

*Exception: Raceways as covered in Articles 345, 346, 347, and 348.*

**(b) Cables and Electrical Nonmetallic Tubing Through Metal Framing Members.**

(1) 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 bushings or grommets securely fastened in the opening prior to installation of the cable.

(2) 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 1/16 inch (1.59 mm) in thickness shall be used to protect the cable or tubing.

**(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.** 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, the cable or raceway shall be installed and supported so that the nearest outside surface of the cable or raceway is not less than 1 1/4 inches (31.8 mm) from the nearest edge of the framing member 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 1/16 inch (1.59 mm) thick.

*Exception No. 1: Raceways as covered in Articles 345, 346, 347, and 348.*

*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.*

### 300-5. Underground Installations.

**(a) Minimum Cover Requirements.** Direct buried cable or conduit or other raceways shall be installed to meet the minimum cover requirements of Table 300-5.

**(b) Grounding.** All underground installations shall be grounded and bonded in accordance with Article 250 of this Code.

**(c) Underground Cables Under Buildings.** Underground cable installed under a building shall be in a raceway that is extended beyond the outside walls of the building.

**(d) Protection from Damage.** Direct buried conductors and cables emerging from the ground shall be protected by enclosures or raceways extending from the minimum cover distance required by Section 300-5(a) below grade to a point at least 8 feet (2.44 m) above finished grade. In no case shall the protection be required to exceed 18 inches (457 mm) below finished grade.

Conductors entering a building shall be protected to the point of entrance.

Where the enclosure or raceway is subject to physical damage the conductors shall be installed in rigid metal conduit, intermediate metal conduit, Schedule 80 rigid nonmetallic 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 by approved methods and with identified materials.

**(f) Backfill.** Backfill containing large rock, paving materials, cinders, large or sharply angular substance, or corrosive material shall not be placed in an excavation where materials may damage raceways, cables, 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 or cable, 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 may contact energized live parts shall be sealed or plugged at either or both ends.

**Table 300-5. Minimum Cover Requirements, 0 to 600 Volts, Nominal, Burial in Inches**
**(Cover is defined as the shortest distance 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.)**

| Location of Wiring Method or Circuit | Type of Wiring Method or Circuit | | | | | |
|---|---|---|---|---|---|---|
| | Direct Burial Cables or Conductors | Rigid Metal Conduit or Intermediate Metal Conduit | Rigid Nonmetallic Conduit Approved for Direct Burial Without Concrete Encasement or Other Approved Raceways | Residential Branch Circuits Rated 120 Volts or less with GFCI Protection and Maximum Overcurrent Protection of 20 Amperes | 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 |
| All Locations Not Specified Below | 24 | 6 | 18 | 12 | 6 |
| In Trench Below 2-Inch Thick Concrete or Equivalent | 18 | 6 | 12 | 6 | 6 |
| Under a Building | 0 (In Raceway Only) | 0 | 0 | 0 (In Raceway Only) | 0 (In Raceway Only) |
| Under Minimum of 4-Inch Thick Concrete Exterior Slab with no vehicular traffic and the slab extending not less than 6 inches beyond the underground installation | 18 | 4 | 4 | 6 (Direct Burial) 4 (In Raceway) | 6 (Direct Burial) 4 (In Raceway) |
| One- and Two-Family Dwelling Driveways and Parking areas, and Used for No Other Purpose | 18 | 18 | 18 | 12 | 18 |
| In Solid Rock Where Covered by Minimum of 2 Inches Concrete Extending Down to Rock | 2 (In Raceway Only) | 2 | 2 | 2 (In Raceway Only) | 2 (In Raceway Only) |

Note 1 For SI Units, one inch = 25.4 millimeters
Note 2 Raceways approved for burial only where concrete encased shall require concrete envelope not less than 2 inches thick
Note 3 Lesser depth shall be permitted where cables and conductors rise for terminations or splices or where access is otherwise required.
Note 4 Where one of the conduit types listed in columns 1-3 is combined with one of the circuit types in columns 4 and 5, the shallower depth of burial shall be permitted.

**(h) Bushing.** A bushing, or terminal fitting, with an integral bushed opening shall be used at the end of a conduit or other raceway which 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) Single Conductors.** All conductors of the same circuit and, where used, the neutral and all equipment grounding conductors shall be installed in the same raceway or shall be installed in close proximity in the same trench.

**300-6. Protection Against Corrosion.** Metal raceways, cable armor, boxes, cable sheathing, cabinets, elbows, couplings, fittings, supports, and support hardware shall be of materials suitable for the environment in which they are to be installed.

**(a) General.** Ferrous raceways, cable armor, boxes, cable sheathing, cabinets, metal elbows, couplings, 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 such as zinc, cadmium, or enamel. Where protected from corrosion solely by enamel, they shall not be used out-of-doors or in wet locations as described in (c) below. When boxes or cabinets have an approved system of organic coatings and are marked "Raintight," "Rainproof" or "Outdoor Type," they shall be permitted out-of-doors.

*Exception: Threads at joints shall be permitted to be coated with an identified electrically conductive compound.*

**(b) In Concrete or in Direct Contact with the Earth.** Ferrous or nonferrous metal raceways, cable armor, boxes, cable sheathing, cabinets, elbows, couplings, fittings, supports, and support hardware shall be permitted to be installed in concrete or in direct contact with the earth, or in areas subject to severe corrosive influences when made of material judged suitable for the condition, or when provided with corrosion protection approved for the condition.

**300-9. Grounding Metal Enclosures.** Metal raceways, boxes, cabinets, cable armor, and fittings shall be grounded as required in Article 250.

**300-10. Electrical Continuity of Metal Raceways and Enclosures.** Metal raceways, cable armor, and other metal enclosures for conductors shall be metallically joined together into a continuous electric conductor, and shall be so connected to all boxes, fittings, and cabinets as to provide effective electrical continuity. Raceways and cable assemblies shall be mechanically secured to boxes, fittings, cabinets, and other enclosures.

*Exception No. 1: As provided in Section 370-7(c) for nonmetallic boxes.*

*Exception No. 2: As provided in Section 250-33, Exception No. 2 for metal enclosures.*

**300-11. Securing and Supporting.**

**(a) Secured in Place.** Raceways, cable assemblies, boxes, cabinets, and fittings shall be securely fastened in place. Support wires that do not provide secure support shall not be permitted as the sole support. Equipment that is located within, supported by, or located below a suspended

ceiling shall be permitted to be supplied or controlled by branch-circuit wiring that is supported by the suspended ceiling support wires.

*Exception: As permitted elsewhere in this Code.*

**(b) Raceways Used as Means of Support.** Raceways shall not be used as a means of support for other raceways, cables, or nonelectric equipment.

*Exception No. 1: Where the raceways or means of support are identified for the purpose.*

*Exception No. 2: Raceways containing power supply conductors for electrically controlled equipment shall be permitted to support Class 2 circuit conductors or cables that are solely for the purpose of connection to the equipment control circuits.*

*Exception No. 3: As permitted in Sections 370-13 for boxes or conduit bodies, or 410-16(f) for fixtures.*

**300-12. Mechanical Continuity – Raceways and Cables.** Metal or nonmetallic raceways, cable armors, and cable sheaths shall be continuous between cabinets, boxes, fittings, or other enclosures or outlets.

*Exception: Short sections of raceways used to provide support or protection of cable assemblies from physical damage.*

**300-13. Mechanical and Electrical Continuity – Conductors.**

**(a) General.** Conductors in raceways shall be continuous between outlets, devices, etc., and there shall be no splice or tap within a raceway itself.

*Exception No. 3: As provided in Section 300-15(a), Exception No. 1 for boxes or fittings.*

*Exception No. 4: As provided in Section 352-7 for surface metal raceways.*

**(b) Device Removal.** In multiwire branch circuits the continuity of a grounded conductor shall not be dependent upon device connections, such as lampholders, receptacles, etc., where the removal of such devices would interrupt the continuity.

**300-14. Length of Free Conductors at Outlets, Junctions, and Switch Points.** At least 6 inches (152 mm) of free conductor shall be left at each outlet, junction, and switch point for splices or the connection of fixtures or devices.

*Exception: Conductors that are not spliced or terminated at the outlet, junction, or switch point.*

**300-15. Boxes or Fittings – Where Required.**

**(a) Box or Fitting.** A box or fitting shall be installed at each conductor splice connection point, outlet, switch point, junction point, or pull point for the connection of conduit, electrical metallic tubing, surface raceway, or other raceways.

*Exception No. 1: A box or fitting shall not be required for a conductor splice connection in surface raceways, wireways, header-ducts, multioutlet assemblies, auxiliary gutters, cable trays, and conduit bodies complying with Sections 370-6(c) and 370-18 and having removable covers which are accessible after installation.*

*Exception No. 2: As permitted in Section 410-31 where a fixture is used as a raceway.*

**(b) Box Only.** A box shall be installed at each conductor splice connection point, outlet, switch point, junction point, or pull point for the connection of Type AC cable, Type MC cable, mineral-insulated, metal-sheathed cable, nonmetallic-sheathed cable, or other cables, at the connection point between any such cable system and a raceway system and at each outlet and switch point for concealed knob-and-tube wiring.

*Exception No. 1: Where cables enter or exit from conduit or tubing which 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 wires or cables from abrasion.*

*Exception No. 2: As permitted by Section 336-16 for insulated outlet devices supplied by nonmetallic-sheathed cable.*

*Exception No. 5: 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 without a separate box.*

(FPN): See Sections 336-15, Exception No. 2; 545-10; 550-10(j); and 551-47(e), Exception No. 1 in the NEC.

*Exception No. 7: A conduit body shall be permitted in lieu of a box where installed to comply with Section 370-6(c) and Section 370-18.*

*Exception No. 8: Where a device identified and listed as suitable for installation without a box is used with a closed-loop power distribution system.*

**(c) Fittings and Connectors.** Fittings and connectors shall be used only with the specific wiring methods for which they are designed and listed.

**300-17. Number and Size of Conductors in Raceway.** The number and size of conductors in any raceway shall not be more than will permit dissipation of the heat and ready installation or withdrawal of the conductors without damage to the conductors or to their insulation.

(FPN): See the following sections of this Code: electrical nonmetallic tubing, 331-6; conduit, 345-7 and 346-6; electrical metallic tubing, 348-6; rigid nonmetallic conduit, 347-11; flexible metallic tubing, 349-12; flexible metal conduit, 350-3; liquidtight flexible metal conduit, 351-6; liquidtight nonmetallic flexible conduit, 351-25; Class 1, Class 2, and Class 3 circuits, Article 725 in the NEC; and fire protective signaling circuits, Article 760 in the NEC.

**300-18. Raceway Installations.** Raceways shall be installed complete between outlet, junction or splicing points prior to the installation of conductors.

*Exception No. 1: Exposed raceways having a removable cover.*

*Exception No. 2: Where required to facilitate the installation of utilization equipment.*

*Exception No. 3: Prewired assemblies in accordance with Articles 349 and 350.*

**300-20. Induced Currents in Metal Enclosures or Metal Raceways.**

**(a) Conductors Grouped Together.** Where conductors carrying alternating current are installed in metal enclosures or metal raceways, they shall be so arranged as to avoid heating the surrounding metal by induction. To accomplish this, all phase conductors and, where used, the neutral and all equipment grounding conductors shall be grouped together.

*Exception No. 1: As permitted in Section 250-50, Exception for equipment grounding connections.*

**(b) Individual Conductors.** Where a single conductor carrying alternating current passes through metal with magnetic properties the inductive effect shall be minimized by: (1) cutting slots in the metal between the individual holes through which the individual conductors pass, or (2) passing all the conductors in the circuit through an insulating wall sufficiently large for all of the conductors of the circuit.

(FPN): 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 so made that the possible spread of fire or products of combustion will not be substantially increased. Openings around electrical penetrations through fire-resistance rated walls, partitions, floors, or ceilings shall be firestopped using approved methods to maintain the fire-resistance rating.

**300-22. Wiring in Ducts, Plenums, and Other Air-Handling Spaces.** The provisions of this section apply to the installation and uses of electric wiring and equipment in ducts, plenums, and other air-handling spaces.

(FPN): See Article 424, Part F for Electric Duct Heaters.

**(b) Ducts or Plenums Used for Environmental Air.** Only wiring methods consisting of Type MI cable, 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 shall be installed in ducts or plenums specifically fabricated to transport environmental air. Flexible metal conduit and liquidtight flexible metal conduit shall be permitted, in lengths not to exceed 4 feet (1.22 m), to connect physically adjustable equipment and devices permitted to be in these ducts and plenum chambers. The connectors used with flexible metal conduit shall effectively close any openings in the connection. Equipment and devices shall be permitted within such ducts or plenum chambers only if necessary for their 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 fixtures shall be permitted.

**(c) Other Space Used for Environmental Air.** Section 300-22(c) applies to space used for environmental air-handling purposes other than ducts and plenums as specified in Sections 300-22(a) and 300-22(b). Only wiring methods consisting of Type MI cable, Type MC cable without an overall nonmetallic covering, Type AC cable, or other factory-assembled

multiconductor control or power cable which is specifically listed for the use shall be installed in such other space.

Other type cables and conductors shall be installed in electrical metallic tubing, flexible metallic tubing, intermediate metal conduit, rigid metal conduit, flexible metal conduit, or where accessible, surface metal raceway or wireway with metal covers.

Electric equipment with a metal enclosure or with a nonmetallic enclosure listed for the use and having adequate fire-resistant and low-smoke-producing characteristics, and associated wiring material suitable for the ambient temperature shall be permitted to be installed in such other space unless prohibited elsewhere in this Code.

(FPN): The space over a hung ceiling used for environmental air-handling purposes is an example of the type of other space to which Section 300-22(c) applies.

*Exception No. 1: Liquidtight flexible metal conduit in single lengths not exceeding 6 feet (1.83 m).*

*Exception No. 2: Integral fan systems specifically identified for such use.*

*Exception No. 3: This section does not include habitable rooms or areas of buildings, the prime purpose of which is not air handling.*

*Exception No. 5: This section does not include the joist or stud spaces in dwelling units when wiring or equipment passes through such spaces perpendicular to the long dimension of such spaces.*

## ARTICLE 305 — TEMPORARY WIRING

**305-1. Scope.** The provisions of this article apply to temporary electrical power and lighting wiring methods which may be of a class less than would be required for a permanent installation.

**305-2. Other Articles.** Except as specifically modified in this article, all other requirements of this Code for permanent wiring shall apply to temporary wiring installations.

### 305-3. Time Constraints.

**(a) During the Period of Construction.** Temporary electrical power and lighting installations shall be permitted during the period of construction, remodeling, maintenance, repair, or demolition of buildings, structures, equipment, or similar activities.

**(b) 90 Days.** Temporary electrical power and lighting installations shall be permitted for a period not to exceed 90 days for Christmas decorative lighting and similar purposes.

**(c) Emergencies and Tests.** Temporary electrical power and lighting installations shall be permitted during emergencies and for tests, experiments, and developmental work.

**(d) Removal.** Temporary wiring shall be removed immediately upon completion of construction or purpose for which the wiring was installed.

## 305-4. General.

**(a) Services.** Services shall be installed in conformance with Article 230.

**(b) Feeders.** Feeders shall be protected as provided in Article 240. They shall originate in an approved distribution center. Conductors shall be permitted within cable assemblies; or, multiconductor cord or cable of a type identified in Table 400-4 in the NEC for hard usage or extra hard usage. Where the voltage does not exceed 150 volts to ground and where not subject to physical damage, feeders shall be permitted to be run as open conductors if supported on insulators at intervals of not more than 10 feet (3.05 m).

*Exception: Where installed for the purposes specified in Section 305-3(c).*

**(c) Branch Circuits.** All branch circuits shall originate in an approved power outlet or panelboard. Conductors shall be permitted within cable assemblies; or, multiconductor cord or cable of a type identified in Table 400-4 in the NEC for hard usage or extra hard usage. All conductors shall be protected as provided in Article 240. Where the voltage does not exceed 150 volts to ground and where not subject to physical damage, branch circuits shall be permitted to be run as open conductors if supported on insulators at intervals of not more than 10 feet (3.05 m). No open wiring branch circuit conductors shall be laid on the floor or ground.

*Exception: Where installed for the purposes specified in Section 305-3(c).*

**(d) Receptacles.** All receptacles shall be of the grounding type. Unless installed in a continuous grounded metal raceway or metal-covered cable all branch circuits shall contain a separate equipment grounding conductor and all receptacles shall be electrically connected to the equipment grounding conductors. Receptacles on construction sites shall not be installed on branch circuits which supply temporary lighting. Receptacles shall not be connected to the same ungrounded conductor of multiwire circuits which supply temporary lighting.

**(e) Disconnecting Means.** Suitable disconnecting switches or plug connectors shall be installed to permit the disconnection of all ungrounded conductors of each temporary circuit. Multiwire branch circuits shall be provided with a means to disconnect simultaneously all ungrounded conductors at the power outlet or panelboard where the branch circuit originated. Approved handle ties shall be permitted.

**(f) Lamp Protection.** All lamps for general illumination shall be protected from accidental contact or breakage by a suitable fixture or lampholder with a guard.

Brass shell, paper-lined sockets, or other metal-cased sockets shall not be used unless the shell is grounded.

**(g) Splices.** On construction sites a box shall not be required for splices or junction connections where the circuit conductors are multiconductor cord or cable assemblies or open conductors. See Sections 110-14(b) and 400-9. A box, conduit body, or terminal fitting having a separately bushed hole for each conductor shall be used wherever a change is made to a conduit or tubing system or a metal-jacketed cable system.

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

**305-5. Grounding.** All grounding shall conform with Article 250.

**305-6. Ground-Fault Protection for Personnel.** Ground-fault protection for personnel on construction sites shall be provided to comply with (a) or (b) below.

**(a) Ground-Fault Circuit-Interrupters.** All 125-volt, single-phase, 15- and 20-ampere receptacle outlets which are not a part of the permanent wiring of the building or structure and which are in use by personnel shall have ground-fault circuit-interrupter protection for personnel.

*Exception: Receptacles on a 2-wire, single-phase portable or vehicle-mounted generator rated not more than 5 kW, where the circuit conductors of the generator are insulated from the generator frame and all other grounded surfaces.*

**(b) Assured Equipment Grounding Conductor Program.** A written procedure shall be continuously enforced at the construction site by one or more designated persons to assure that equipment grounding conductors for all cord sets, receptacles which are not a part of the permanent wiring of the building or structure and equipment connected by cord and plug are installed and maintained in accordance with the applicable requirements of Sections 210-7(c), 250-45, 250-59, and 305-4(d).

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

a. All equipment grounding conductors shall be tested for continuity and shall be electrically continuous.

b. Each receptacle and attachment plug shall be tested for correct attachment of the equipment grounding conductor. The equipment grounding conductor shall be connected to its proper terminal.

c. All required tests shall be performed:

1. Before first use on the construction site.

2. When there is evidence of damage.

3. Before equipment is returned to service following any repairs.

4. At intervals not exceeding 3 months.

(2) The tests required in (1) above shall be recorded and made available to the authority having jurisdiction.

# ARTICLE 310 — CONDUCTORS FOR GENERAL WIRING

**310-1. Scope.** This article covers general requirements for conductors 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.

(FPN): For flexible cords and cables, see Article 400. For fixture wires, see Article 402 in the NEC.

**310-2. Conductors.**

**(a) Insulated.** Conductors shall be insulated.

*Exception: Where covered or bare conductors are specifically permitted elsewhere in this Code.*

(FPN): See Section 250-152 for insulation of neutral conductors of a solidly grounded high-voltage system.

**(b) Conductor Material.** Conductors in this article shall be of aluminum, copper-clad aluminum, or copper unless otherwise specified.

**310-3. Stranded Conductors.** Where installed in raceways, conductors of size No. 8 and larger shall be stranded.

**310-5. Minimum Size of Conductors.** Whether solid or stranded, conductors shall not be smaller than No. 14 copper or No. 12 aluminum or copper-clad aluminum.

*Exception No. 2: For fixture wire as permitted by Section 410-24 in the NEC.*

*Exception No. 6: For Class 1, Class 2, and Class 3 circuits as permitted by Sections 725-16 and 725-37 in the NEC.*

*Exception No. 7: For fire protective signaling circuits as permitted by Sections 760-16, 760-25, and 760-51 in the NEC.*

**310-8. Wet Locations.**

**(a) Insulated Conductors.** Insulated conductors used in wet locations shall be (1) lead-covered; (2) Types RHW, TW, THW, THHW, THWN, XHHW; or (3) of a type listed for use in wet locations.

**(b) Cables.** Cables of one or more conductors used in wet locations shall be of a type listed for use in wet locations.

**310-10. Temperature Limitation of Conductors.** No conductor shall be used in such a manner that its operating temperature will exceed that designated for the type of insulated conductor involved. In no case shall conductors be associated together in such a way with respect to type of circuit, the wiring method employed, or the number of conductors that the limiting temperature of any conductor is exceeded.

(FPN): The temperature rating of a conductor (see Tables 310-13 and 310-61 in the NEC) is the maximum temperature, at any location along its length, that the conductor can withstand over a prolonged time period without serious degradation.

The correction factors at the bottom of Table 310-16 and the notes to this table provide guidance for coordinating conductor sizes, types, ampacities, ambient temperatures, and number of associated conductors.

The principal determinants of operating temperature are:

1. Ambient temperature. Ambient temperature may vary along the conductor length as well as from time to time.

2. Heat generated internally in the conductor as the result of load current flow.

3. The rate at which generated heat dissipates into the ambient medium. Thermal insulation which covers or surrounds conductors will affect the rate of heat dissipation.

4. Adjacent load-carrying conductors. Adjacent conductors have the dual effect of raising the ambient temperature and impeding heat dissipation.

## 310-11. Marking.

**(a) Required Information.** All conductors and cables shall be marked to indicate the following information, using the applicable method described in (b) below.

**(1)** The maximum rated voltage for which the conductor was listed.

**(2)** The proper type letter or letters for the type of wire or cable as specified elsewhere in this Article.

**(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.

**(b) Method of Marking.**

**(1) Surface Marking.** The following conductors and cables shall be durably marked on the surface. The AWG size or circular mil area shall be repeated at intervals not exceeding 24 inches (610 mm). All other markings shall be repeated at intervals not exceeding 40 inches (1.02 m).

a. Single- and multiconductor rubber- and thermoplastic-insulated wire and cable.

b. Nonmetallic-sheathed cable.

c. Service-entrance cable.

d. Underground feeder and branch-circuit cable.

**(2) Marker Tape.** Metal-covered multiconductor cables shall employ a marker tape located within the cable and running for its complete length.

*Exception No. 2: Type AC cable.*

*Exception No. 3: The information required in Section 310-11(a) shall be permitted to be durably marked on the outer nonmetallic covering of Type MC or Type PLTC cables at intervals not exceeding 40 inches (1.02 m).*

(FPN): Included in the group of metal-covered cables is: Type AC cable (Article 333).

**(3) Tag Marking.** The following conductors and cables shall be marked by means of a printed tag attached to the coil, reel, or carton:

c. Metal-covered, single-conductor cables.

e. Type AC cable.

**310-12. Conductor Identification.**

**(a) Grounded Conductors.** Insulated conductors of No. 6 or smaller, intended for use as grounded conductors of circuits, shall have an outer identification of a white or natural gray color. Multiconductor flat cable No. 4 or larger shall be permitted to employ an external ridge on the grounded conductor.

*Exception No. 4: A conductor identified as required by Section 210-5(a) for branch circuits.*

Wires having their outer covering finished to show a white or natural gray color but having colored tracer threads in the braid, identifying the source of manufacture, shall be considered as meeting the provisions of this section.

(FPN): For identification requirements for conductors larger than No. 6, see Section 200-6.

**(b) Equipment Grounding Conductors.** Bare, covered or insulated grounding conductors shall be permitted. Individually covered or insulated grounding conductors shall have a continuous outer finish that is either green, or green with one or more yellow stripes.

*Exception No. 1: An insulated or covered conductor larger than No. 6 shall, at the time of installation, be permitted to be permanently identified as a grounding conductor at each end and at every point where the conductor is accessible. Identification shall be accomplished by one of the following means:*

*a. Stripping the insulation or covering from the entire exposed length;*

*b. Coloring the exposed insulation or covering green; or*

*c. Marking the exposed insulation or covering with green colored tape or green colored adhesive labels.*

**(c) Ungrounded Conductors.** Conductors which are intended for use as ungrounded conductors, whether used as single conductors or in multiconductor cables, shall be finished to be clearly distinguishable from grounded and grounding conductors. Ungrounded conductors shall be distinguished by colors other than white, natural gray, or green; or by a combination of color plus distinguishing marking. Distinguishing markings shall also be in a color other than white, natural gray, or green, and shall consist of a stripe or stripes or a regularly spaced series of identical marks. Distinguishing markings shall not conflict in any manner with the surface markings required by Section 310-11(b)(1).

**310-14. Aluminum Conductor Material.** Solid aluminum conductors No. 8, 10, and 12 AWG shall be made of an AA-8000 series electrical grade aluminum alloy conductor material. Stranded aluminum conductors No. 8 AWG through 1000 kcmil marked as Type XHHW, 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.

**310-15. Ampacity.** Ampacities for conductors rated 0 through 2000 volts shall be as specified in Table 310-16 and its accompanying notes.

(FPN): Table 310-16 is an application table that is for use in determining conductor sizes on loads calculated in accordance with Article 220.

**(c) Selection of Ampacity.** When more than one calculated or tabulated ampacity could apply for a given circuit length, the lowest value shall be used.

*Exception: Where two different ampacities apply to adjacent portions of a circuit, the higher ampacity shall be permitted to be used beyond the point of transition, a distance equal to 10 feet (3.05 m) or 10 percent of the circuit length figured at the higher ampacity, whichever is less.*

**Table 310-16. Ampacities of Insulated Conductors Rated 0-2000 Volts, 60° to 90°C (140° to 194°F) Not More Than Three Conductors in Raceway or Cable or Earth (Directly Buried), Based on Ambient Temperature of 30°C (86°F)**

| Size | Temperature Rating of Conductor. See Table 310-13. | | | | | | | | Size |
|---|---|---|---|---|---|---|---|---|---|
| | 60°C (140°F) | 75°C (167°F) | 85°C (185°F) | 90°C (194°F) | 60°C (140°F) | 75°C (167°F) | 85°C (185°F) | 90°C (194°F) | |
| AWG | TYPES †TW, †UF | TYPES †FEPW, †RH, †RHW, †THHW, †THW, †THWN, †XHHW †USE, †ZW | TYPE V | TYPES TA, TBS, SA SIS, †FEP, †FEPB, †RHH, †THHN, †THHW, †XHHW | TYPES †TW, †UF | TYPES †RH, †RHW, †THHW, †THW, †THWN, †XHHW †USE | TYPE V | TYPES TA, TBS, SA, SIS, †RHH, †THHW, †THHN, †XHHW | AWG |
| | COPPER | | | | ALUMINUM OR COPPER-CLAD ALUMINUM | | | | |
| 18 | .... | .... | .... | 14 | .... | .... | .... | .... | .... |
| 16 | .... | .... | 18 | 18 | .... | .... | .... | .... | .... |
| 14 | 20† | 20† | 25 | 25† | .... | .... | .... | .... | .... |
| 12 | 25† | 25† | 30 | 30† | 20† | 20† | 25 | 25† | 12 |
| 10 | 30 | 35† | 40 | 40† | 25 | 30† | 30 | 35† | 10 |
| 8 | 40 | 50 | 55 | 55 | 30 | 40 | 40 | 45 | 8 |
| 6 | 55 | 65 | 70 | 75 | 40 | 50 | 55 | 60 | 6 |
| 4 | 70 | 85 | 95 | 95 | 55 | 65 | 75 | 75 | 4 |
| 3 | 85 | 100 | 110 | 110 | 65 | 75 | 85 | 85 | 3 |
| 2 | 95 | 115 | 125 | 130 | 75 | 90 | 100 | 100 | 2 |
| 1 | 110 | 130 | 145 | 150 | 85 | 100 | 110 | 115 | 1 |
| 1/0 | 125 | 150 | 165 | 170 | 100 | 120 | 130 | 135 | 1/0 |
| 2/0 | 145 | 175 | 190 | 195 | 115 | 135 | 145 | 150 | 2/0 |
| 3/0 | 165 | 200 | 215 | 225 | 130 | 155 | 170 | 175 | 3/0 |
| 4/0 | 195 | 230 | 250 | 260 | 150 | 180 | 195 | 205 | 4/0 |
| | AMPACITY CORRECTION FACTORS | | | | | | | | |
| Ambient Temp. °C | For ambient temperatures other than 30°C (86°F), multiply the ampacities shown above by the appropriate factor shown below. | | | | | | | | Ambient Temp. °F |
| 21-25 | 1.08 | 1.05 | 1.04 | 1.04 | 1.08 | 1.05 | 1.04 | 1.04 | 70-77 |
| 26-30 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 79-86 |
| 31-35 | .91 | .94 | .95 | .96 | .91 | .94 | .95 | .96 | 88-95 |
| 36-40 | .82 | .88 | .90 | .91 | .82 | .88 | .90 | .91 | 97-104 |
| 41-45 | .71 | .82 | .85 | .87 | .71 | .82 | .85 | .87 | 106-113 |
| 46-50 | .58 | .75 | .80 | .82 | .58 | .75 | .80 | .82 | 115-122 |
| 51-55 | .41 | .67 | .74 | .76 | .41 | .67 | .74 | .76 | 124-131 |
| 56-60 | .... | .58 | .67 | .71 | .... | .58 | .67 | .71 | 133-140 |
| 61-70 | .... | .33 | .52 | .58 | .... | .33 | .52 | .58 | 142-158 |
| 71-80 | .... | .... | .30 | .41 | .... | .... | .30 | .41 | 160-176 |

† Unless otherwise specifically permitted elsewhere in this Code, the overcurrent protection for conductor types marked with an obelisk (†) shall not exceed 15 amperes for 14 AWG, 20 amperes for 12 AWG, and 30 amperes for 10 AWG copper; or 15 amperes for 12 AWG and 25 amperes for 10 AWG aluminum and copper-clad aluminum after any correction factors for ambient temperature and number of conductors have been applied.

### Notes to Table 310-16

**1. Explanation of Tables.** For explanation of Type Letters, and for recognized size of conductors for the various conductor insulations, see Section 310-13 in the NEC. For installation requirements, see Sections 310-1 through 310-10, and the various articles of this Code. For flexible cords, see Tables 400-4, 400-5(A), and 400-5(B) in the NEC.

**3. 120/240 Volts, 3-Wire, Single-Phase Dwelling Services.** In dwelling units, conductors, as listed below, shall be permitted to be utilized as 120/240-volt, 3-wire, single-phase service-entrance conductors and feeder conductors in raceway or cable with or without an equipment grounding conductor. The grounded conductor shall be permitted to be not more than two AWG sizes smaller than the ungrounded conductors for application of this note, provided the requirements of Sections 215-2, 220-22, and 230-42 are met.

**Conductor Types and Sizes**
**RH-RHH-RHW-THHW-THW-THWN-THHN-XHHW-USE**

| Copper | Aluminum and Copper-Clad AL | Service Rating in Amps |
|---|---|---|
| AWG | AWG | |
| 4 | 2 | 100 |
| 3 | 1 | 110 |
| 2 | 1/0 | 125 |
| 1 | 2/0 | 150 |
| 1/0 | 3/0 | 175 |
| 2/0 | 4/0 | 200 |
| 3/0 | 250 kcmil | 225 |
| 4/0 | 300 kcmil | 250 |

**8. Ampacity Adjustment Factors.**

**(a) More than Three Conductors in a Raceway or Cable.** Where the number of conductors in a raceway or cable exceeds three, the ampacities given in Table 310-16 shall be reduced as shown in the following table:

| Numbers of Conductors | Percent of Values in Table 310-16 as Adjusted for Ambient Temperature If Necessary |
|---|---|
| 4 through 6 | 80 |
| 7 through 9 | 70 |

Where single conductors or multiconductor cables are stacked or bundled longer than 24 inches (610 mm) without maintaining spacing and are not installed in raceways, the ampacity of each conductor shall be reduced as shown in the above table.

*Exception No. 3: Derating factors shall not apply to conductors in nipples having a length not exceeding 24 inches (610 mm).*

*Exception No. 4: Derating factors shall not apply to underground conductors entering or leaving an outdoor trench if those conductors have physical protection in the form of rigid metal conduit, intermediate metal conduit or*

*rigid nonmetallic conduit having a length not exceeding 10 feet (3.05 m) above grade and the number of conductors does not exceed 4.*

**11. Grounding or Bonding Conductor.** A grounding or bonding conductor shall not be counted when applying the provisions of Note 8.

## ARTICLE 331 — ELECTRICAL NONMETALLIC TUBING

### A. General

**331-1. Definition.** Electrical nonmetallic tubing is a pliable corrugated raceway of circular cross-section with integral or associated couplings, connectors and fittings listed for the installation of electric conductors. It is composed of a material that is resistant to moisture, chemical atmospheres, and is flame-retardant.

A pliable raceway is a raceway which can be bent by hand with a reasonable force, but without other assistance.

(FPN): It is intended that the material used has ignitibility, flammability, smoke generation, and toxicity characteristics that do not exceed those of rigid (nonplasticized) polyvinyl chloride.

**331-2. Other Articles.** Installations for electrical nonmetallic tubing shall comply with the provisions of the applicable sections of Article 300. Where equipment grounding is required by Article 250, a separate equipment grounding conductor shall be installed in the raceway.

**331-3. Uses Permitted.** The use of electrical nonmetallic tubing and fittings shall be permitted:

**(1)** For exposed work, where not subject to physical damage; where the building does not exceed three floors above grade.

(FPN): See Section 336-4(a) for definition of first floor.

**(2)** Concealed within walls, floors, and ceilings where the walls, floors, and ceilings provide a thermal barrier of material which has at least a 15-minute finish rating as identified in listings of fire-rated assemblies.

**(4)** In concealed, dry, and damp locations not prohibited by Section 331-4.

**(5)** Above suspended ceilings where the suspended ceilings provide a thermal barrier of material which has at least a 15-minute finish rating as identified in listings of fire-rated assemblies.

**(6)** Embedded in poured concrete, provided fittings identified for this purpose are used for connections.

(FPN): Extreme cold may cause some types of nonmetallic conduits to become brittle and, therefore, more susceptible to damage from physical contact.

**331-4. Uses Not Permitted.** Electrical nonmetallic tubing shall not be used:

**(2)** For the support of fixtures and other equipment.

**(3)** Where subject to ambient temperatures exceeding those for which the tubing is listed.

(4) For conductors whose insulation temperature limitations would exceed those for which the tubing is listed.

(5) For direct earth burial.

(7) In exposed locations except as permitted by Sections 331-3(1) and (5).

### B. Installation

**331-5. Size.**

**(a) Minimum.** Tubing smaller than 1/2-inch electrical trade size shall not be used.

**(b) Maximum.** Tubing larger than 1-inch electrical trade size shall not be used.

**331-6. Number of Conductors in Tubing.** The number of conductors in a single tubing shall not exceed that permitted by the percentage fill in Table 1 in Tables and Examples.

**331-7. Trimming.** All cut ends of tubing shall be trimmed inside and outside to remove rough edges.

**331-8. Joints.** All joints between lengths of tubing and between tubing and couplings, fittings and boxes shall be by an approved method.

**331-9. Bends – How Made.** Bends of electrical nonmetallic tubing shall be so made that the tubing will not be damaged and that the internal diameter of the tubing will not be effectively reduced. Bends shall be permitted to be made manually without auxiliary equipment and the radius of the curve of the inner edge of such bends shall not be less than shown in Table 346-10.

**331-10. Bends – Number in One Run.** There shall not be more than the equivalent of four quarter bends (360 degrees total) between pull points, e.g., conduit bodies and boxes.

**331-11. Supports.** Electrical nonmetallic tubing shall be installed as a complete system as provided in Article 300 and shall be securely fastened in place. Tubing shall be firmly fastened within 3 feet (914 mm) of each outlet box, junction box, cabinet or fitting. Tubing shall be secured at least every 3 feet (914 mm).

**331-12. Boxes and Fittings.** Boxes and fittings shall comply with the applicable provisions of Article 370.

**331-13. Splices and Taps.** Splices and taps shall be made only in junction boxes, outlet boxes or conduit bodies. See Article 370.

**331-14. Bushings.** Where a tubing enters a box, fitting, or other enclosure, a bushing or adapter shall be provided to protect the wire from abrasion unless the box, fitting, or enclosure design provides equivalent protection.

(FPN): See Section 373-6(c) for the protection of conductors No. 4 AWG or larger.

# ARTICLE 333 — ARMORED CABLE

## Type AC Cable

**333-1. Definition.** Type AC cable is a fabricated assembly of insulated conductors in a flexible metallic enclosure. See Section 333-4.

**333-2. Other Articles.** Type AC cable shall comply with this article and also with the applicable provisions of other articles in this Code, especially Article 300.

**333-3. Marking.** The provisions of Section 310-11 shall apply, except that Type AC cable shall have ready identification of the maker by distinctive external markers on the cable sheath throughout its entire length. Cables that are flame-retardant and have limited smoke characteristics shall be permitted to be identified with the suffix, LS.

**333-4. Construction.** Type AC cable shall have an armor of flexible metal tape. The insulated conductors shall be in accordance with Section 333-5. Cables of the AC type, except ACL, shall have an internal bonding strip of copper or aluminum, in intimate contact with the armor for its entire length.

**333-5. Conductors.** Insulated conductors shall be of a type listed in Table 310-13 or ones which are identified for use in this cable. In addition, the conductors shall have an overall moisture-resistant and fire-retardant fibrous covering. For Type ACT, a moisture-resistant fibrous covering shall be required only on the individual conductors. The ampacity shall be determined by Section 310-15.

*Exception: Armored cable installed in thermal insulation shall have conductors rated at 90°C (194°F). The ampacity of cable installed in these applications shall be that of 60°C (140°F) conductors.*

**333-6. Use.**

**(a) Uses Permitted.** Except where otherwise specified elsewhere in this Code, and where not subject to physical damage, Type AC cable shall be permitted for branch circuits and feeders in both exposed and concealed work.

Type AC cable shall be permitted in dry locations; for underplaster extensions as provided in Article 344 in the NEC; and embedded in plaster finish on brick or other masonry, except in damp or wet locations. It shall be permissible to run or fish this cable in the air voids of masonry block or tile walls; where such walls are exposed or subject to excessive moisture or dampness or are below grade line, Type ACL cable shall be used. This cable shall contain lead-covered conductors (Type ACL) if used where exposed to the weather or to continuous moisture; for underground runs in raceways; where embedded in masonry, concrete, or fill in buildings in course of construction; or where exposed to oil, or other conditions having a deteriorating effect on the insulation.

**333-7. Supports.** Type AC cable shall be secured by approved staples, straps, hangers, or similar fittings so designed and installed as not to damage the cable at intervals not exceeding 4½ feet (1.37 m) and within 12 inches (305 mm) from every outlet box, junction box, cabinet, or fitting.

*Exception No. 1: Where cable is fished.*

*Exception No. 2: Lengths of not more than 2 feet (610 mm) at terminals where flexibility is necessary.*

*Exception No. 3: Lengths of not more than 6 feet (1.83 m) from an outlet for connections within an accessible ceiling to lighting fixtures or equipment.*

**333-8. Bends.** All bends shall be made so that the cable will not be damaged, and the radius of the curve of the inner edge of any bend shall not be less than five times the diameter of the Type AC cable.

**333-9. Boxes and Fittings.** At all points where the armor of AC cable terminates, a fitting shall be provided to protect wires from abrasion, unless the design of the outlet boxes or fittings is such as to afford equivalent protection, and, in addition, an approved insulating bushing or its equivalent approved protection shall be provided between the conductors and the armor. The connector or clamp by which the Type AC cable is fastened to boxes or cabinets shall be of such design that the insulating bushing or its equivalent will be visible for inspection. This bushing shall not be required with lead-covered cables where so installed that the lead sheath will be visible for inspection. Where change is made from Type AC cable to other cable or raceway wiring methods, a box, fitting or conduit body shall be installed at junction points as required in Section 300-15.

**333-10. Through Studs, Joists, and Rafters.** Type AC cable shall comply with Section 300-4 where installed through studs, joists, rafters, or similar wood members.

**333-11. Exposed Work.** Exposed runs of cable shall closely follow the surface of the building finish or of running boards.

*Exception No. 1: Lengths of not more than 24 inches (610 mm) at terminals where flexibility is necessary.*

*Exception No. 2: On the underside of floor joists in basements where supported at each joist and so located as not to be subject to physical damage.*

*Exception No. 3: Lengths of not more than 6 feet (1.83 m) from an outlet for connection within an accessible ceiling to lighting fixtures or other equipment.*

**333-12. In Accessible Attics.** Type AC cables in accessible attics or roof spaces shall be installed as specified in (a) and (b) below.

**(a) Where Run Across the Top of Floor Joists.** Where run across the top of floor joists, or within 7 feet (2.13 m) of floor or floor joists across the face of rafters or studding, in attics and roof spaces which are accessible, the cable shall be protected by substantial guard strips which are at least as high as the cable. Where this space is not accessible by permanent stairs or ladders, protection shall only be required within 6 feet (1.83 m) of the nearest edge of the scuttle hole or attic entrance.

**(b) Where Carried Along the Sides of Floor Joists.** Where cable is carried along the sides of rafters, studs, or floor joists, neither guard strips nor running boards shall be required.

# ARTICLE 336 — METALLIC-SHEATHED CABLE

### Types NM and NMC

### A. General

**336-1. Definition.** Nonmetallic-sheathed cable is a factory assembly of two or more insulated conductors having an outer sheath of moisture-resistant, flame-retardant, nonmetallic material.

**336-2. Other Articles.** In addition to the provisions of this article, installations of nonmetallic-sheathed cable shall comply with the other applicable provisions of this Code, especially Articles 300 and 310.

**336-3. Uses Permitted.** Type NM and Type NMC cables shall be permitted to be used in one- and two-family dwellings, multifamily dwellings and other structures, except as prohibited in Section 336-4.

(FPN): See Section 310-10 for temperature limitation of conductors.

**(a) Type NM.** Type NM cable shall be permitted for both exposed and concealed work in normally dry locations. It shall be permissible to install or fish Type NM cable in air voids in masonry block or tile walls where such walls are not exposed or subject to excessive moisture or dampness.

**(b) Type NMC.** Type NMC cable shall be permitted: (1) for both exposed and concealed work in dry, moist or damp locations; (2) in outside and inside walls of masonry block or tile; (3) in a shallow chase in masonry, concrete, or adobe protected against nails or screws by a steel plate at least $^1/_{16}$ inch (1.59 mm) thick and covered with plaster, adobe, or similar finish.

**336-4. Uses Not Permitted.**

**(a) Type NM or NMC.** Types NM and NMC cables shall not be used: (1) in any dwelling or structure exceeding three floors above grade; or (2) as service-entrance cable. For the purpose of this article, the first floor of a building shall be that floor that has fifty percent or more of the exterior wall surface area level with or above finished grade. One additional level that is the first level and not designed for human habitation and used only for vehicle parking, storage, or similar use shall be permitted.

**(b) Type NM.** Type NM cable shall not be installed: (2) where embedded in masonry, concrete, adobe, fill, or plaster; (3) in a shallow chase in masonry, concrete, or adobe and covered with plaster, adobe, or similar finish.

### B. Installation

**336-10. Exposed Work — General.** In exposed work, except as provided in Sections 336-12 and 336-13, the cable shall be installed as specified in (a) and (b) below.

**(a) To Follow Surface.** The cable shall closely follow the surface of the building finish or of running boards.

**(b) Protection from Physical Damage.** The cable shall be protected from physical damage where necessary by conduit, electrical metallic tubing, pipe, guard strips, or other means. Where passing through a floor the

cable shall be enclosed in rigid metal conduit, intermediate metal conduit, electrical metallic tubing, or other metal pipe extending at least 6 inches (152 mm) above the floor.

**336-11. Through Studs, Joists, and Rafters.** The cable shall comply with Section 300-4 where installed through studs, joists, rafters, and similar members.

**336-12. In Unfinished Basements.** Where the cable is run at angles with joists in unfinished basements, it shall be permissible to secure cables not smaller than two No. 6 or three No. 8 conductors directly to the lower edges of the joists. Smaller cables shall either be run through bored holes in joists or on running boards. Where run parallel to the joists, cable of any size shall be secured to the sides or faces of the joists.

**336-13. In Accessible Attics.** The installation of cable in accessible attics or roof spaces shall also comply with Section 333-12.

**336-14. Bends.** Bends in cable shall be so made, and other handling shall be such, that the protective coverings of the cable will not be damaged, and no bend shall have a radius less than five times the diameter of the cable.

**336-15. Supports.** Nonmetallic-sheathed cable shall be secured by staples, straps, or similar fittings so designed and installed as not to damage the cable. Cable shall be secured in place at intervals not exceeding 4½ feet (1.37 m) and within 12 inches (305 mm) from every cabinet, box, or fitting.

*Exception No. 1: For concealed work in finished buildings, or finished panels for prefabricated buildings where such supporting is impracticable, it shall be permissible to fish the cable between access points.*

*Exception No. 2: A wiring device identified for the use, without a separate outlet box, incorporating an integral cable clamp shall be permitted when the cable is secured in place at intervals not exceeding 4½ feet (1.37 m) and within 12 inches (305 mm) from the wiring device wall opening, and there shall be at least a 12-inch (305-mm) loop of unbroken cable or 6 inches (152 mm) of a cable end available on the interior side of the finished wall to permit replacement.*

**336-16. Devices of Insulating Material.** Switch, outlet, and tap devices of insulating material shall be permitted to be used without boxes in exposed cable wiring, and for rewiring in existing buildings where the cable is concealed and fished. Openings in such devices shall form a close fit around the outer covering of the cable, and the device shall fully enclose that part of the cable from which any part of the covering has been removed.

Where connections to conductors are by binding-screw terminals, there shall be available as many terminals as conductors.

*Exception: Where cables are clamped within the structure, and terminals are of a type identified for use with multiconductors.*

**336-17. Boxes of Insulating Material.** Nonmetallic outlet boxes shall be permitted as provided in Section 370-3.

**336-18. Devices with Integral Enclosures.** Wiring devices with integral enclosures identified for such use shall be permitted as provided in Section 300-15(b), Exception No. 5.

# ARTICLE 338 — SERVICE-ENTRANCE CABLE

### Types SE and USE

**338-1. Definition.** Service-entrance cable is a single conductor or multiconductor assembly provided with or without an overall covering, primarily used for services and of the following types:

**(a) Type SE.** Type SE, having a flame-retardant, moisture-resistant covering.

**(b) Type USE.** Type USE, identified for underground use, having a moisture-resistant covering, but not required to have a flame-retardant covering.

Cabled single-conductor Type USE constructions recognized for underground use may have a bare copper conductor cabled with the assembly. Type USE single, parallel, or cabled conductor assemblies recognized for underground use may have a bare copper concentric conductor applied. These constructions do not require an outer overall covering.

(FPN): See Section 230-41, Exception b.

**(c) One Uninsulated Conductor.** If Type SE or USE cable consists of two or more conductors, one shall be permitted to be uninsulated.

**338-2. Uses Permitted as Service-Entrance Conductors.** Service-entrance cable used as service-entrance conductors shall be installed as required by Article 230.

**338-3. Uses Permitted as Branch Circuits or Feeders.**

**(a) Grounded Conductor Insulated.** Type SE service-entrance cables shall be permitted in interior wiring systems where all of the circuit conductors of the cable are of the rubber-covered or thermoplastic type.

**(b) Grounded Conductor Not Insulated.** Type SE service-entrance cables without individual insulation on the grounded circuit conductor shall not be used as a branch circuit or as a feeder within a building, except a cable that has a final nonmetallic outer covering and is supplied by alternating current at not over 150 volts to ground shall be permitted: (1) as a branch circuit to supply only a range, wall-mounted oven, counter-mounted cooking unit, or clothes dryer as covered in Section 250-60, or (2) as a feeder to supply only other buildings on the same premises.

Type SE service-entrance cable shall be permitted for interior use where the fully insulated conductors are used for circuit wiring and the uninsulated conductor is used for equipment grounding purposes.

**(c) Temperature Limitations.** Type SE service-entrance cable used to supply appliances shall not be subject to conductor temperatures in excess of the temperature specified for the type of insulation involved.

**338-4. Interior Installation Methods.** In addition to the provisions of this article, Type SE service-entrance cable used for interior wiring shall be installed in accordance with the provisions of Article 336 and shall comply with the applicable provisions of Article 300.

(FPN): See Section 310-10 for temperature limitation of conductors.

**338-5. Marking.** Service-entrance cable shall be marked as required in Section 310-11. Cable with the neutral conductor smaller than the ungrounded conductors shall be so marked.

## ARTICLE 339 — UNDERGROUND FEEDER AND BRANCH-CIRCUIT CABLE

### Type UF

### 339-1. Description and Marking.

**(a) Description.** Underground feeder and branch-circuit cable shall be an approved Type UF cable in sizes No. 14 copper or No. 12 aluminum or copper-clad aluminum through No. 4/0. The conductors of Type UF shall be one of the moisture-resistant types listed in Table 310-13 in the NEC which is suitable for branch-circuit wiring or one which is identified for such use. In addition to the insulated conductors, the cable shall be permitted to have an approved size of insulated or bare conductor for equipment grounding purposes only. The overall covering shall be flame-retardant, moisture-, fungus-, and corrosion-resistant, and suitable for direct burial in the earth.

**(b) Marking.** In addition to the provisions of Section 310-11, the cable shall have a distinctive marking on the exterior for its entire length specifying the cable type.

**339-2. Other Articles.** In addition to the provisions of this article, installations of underground feeder and branch-circuit cable (Type UF) shall comply with other applicable provisions of this Code, especially Article 300 and Section 310-13 in the NEC.

### 339-3. Use.

**(a) Uses Permitted.**

**(1)** Type UF cable shall be permitted for use underground, including direct burial in the earth, as feeder or branch-circuit cable where provided with overcurrent protection of the rated ampacity as required in Section 339-4.

**(2)** Where single-conductor cables are installed, all cables of the feeder circuit, subfeeder circuit, or branch circuit, including the neutral and equipment grounding conductor, if any, shall be run together in the same trench or raceway.

**(3)** For underground requirements, see Section 300-5.

**(4)** Type UF cable shall be permitted for interior wiring in wet, dry, or corrosive locations under the recognized wiring methods of this Code, and where installed as nonmetallic-sheathed cable, the installation and conductor requirements shall comply with the provisions of Article 336 and shall be of the multiconductor type.

*Exception: Single-conductor cables shall be permitted as the nonheating leads for heating cables as provided in Section 424-43.*

(FPN): See Section 310-10 for temperature limitation of conductors.

**(b) Uses Not Permitted.** Type UF cable shall not be used: (1) as service-entrance cables; (8) embedded in poured cement, concrete, or aggregate, except where embedded in plaster as nonheating leads as provided in Article 424; (9) where exposed to direct rays of the sun, unless identified as sunlight-resistant.

**339-4. Overcurrent Protection.** Overcurrent protection shall be provided in accordance with provisions of Section 240-3.

**339-5. Ampacity.** The ampacity of Type UF cable shall be that of 60°C (140°F) conductors in accordance with Table 310-16.

## ARTICLE 345 — INTERMEDIATE METAL CONDUIT

### A. General

**345-1. Definition.** Intermediate metal conduit is a metal raceway of circular cross section with integral or associated couplings, connectors and fittings approved for the installation of electrical conductors.

**345-2. Other Articles.** Installations for intermediate metal conduit shall comply with the provisions of the applicable sections of Article 300.

**345-3. Uses Permitted.**

**(a) All Atmospheric Conditions and Occupancies.** Use of intermediate metal conduit shall be permitted under all atmospheric conditions and occupancies. Where practicable, dissimilar metals in contact anywhere in the system shall be avoided to eliminate the possibility of galvanic action. Intermediate metal conduit shall be permitted as an equipment grounding conductor.

(FPN): See Section 250-91(b) for types of equipment grounding conductors.

*Exception: Aluminum fittings and enclosures shall be permitted to be used with steel intermediate metal conduit.*

**(b) Corrosion Protection.** Intermediate metal conduit, elbows, couplings, and fittings shall be permitted to be installed in concrete, in direct contact with the earth, or in areas subject to severe corrosive influences when protected by corrosion protection and judged suitable for the condition.

(FPN): See Section 300-6 for protection against corrosion.

**(c) Cinder Fill.** Intermediate metal conduit shall be permitted to be installed in or under cinder fill where subject to permanent moisture when protected on all sides by a layer of noncinder concrete not less than 2 inches (50.8 mm) thick; when the conduit is not less than 18 inches (457 mm) under the fill; or when protected by corrosion protection and judged suitable for the condition.

(FPN): See Section 300-6 for protection against corrosion.

## B. Installation

**345-5. Wet Locations.** All supports, bolts, straps, screws, etc., shall be of corrosion-resistant materials or protected against corrosion by corrosion-resistant materials.

(FPN): See Section 300-6 for protection against corrosion.

**345-6. Size.**

**(a) Minimum.** Conduit smaller than 1/2-inch electrical trade size shall not be used.

**(b) Maximum.** Conduit larger than 4-inch electrical trade size shall not be used.

**345-7. Number of Conductors in Conduit.** The number of conductors in a single conduit shall not exceed that permitted by the percentage fill specified in Table 1, in Tables and Examples using the conduit dimensions of Table 4 in Tables and Examples.

**345-8. Reaming and Threading.** All cut ends of conduits shall be reamed or otherwise finished to remove rough edges. Where conduit is threaded in the field, a standard cutting die with a 3/4-inch (19-mm) taper per foot (305 mm) shall be used.

(FPN): See Standards for Pipe Threads, General Purpose (Inch), ANSI/ASME B.1.20.1-1983.

**345-9. Couplings and Connectors.**

**(a) Threadless.** Threadless couplings and connectors used with conduit shall be made tight. Where buried in masonry or concrete, they shall be the concretetight type. Where installed in wet locations, they shall be the raintight type.

**(b) Running Threads.** Running threads shall not be used on conduit for connection at couplings.

**345-10. Bends — How Made.** Bends of intermediate metal conduit shall be so made that the conduit will not be damaged, and that the internal diameter of the conduit will not be effectively reduced. The radius of the curve of the inner edge of any field bend shall not be less than indicated in Table 346-10.

*Exception: For field bends for conductors without lead sheath and made with a single operation (one shot) bending machine designed for the purpose, the minimum radius shall not be less than that indicated in Table 346-10 Exception.*

**345-11. Bends — Number in One Run.** There shall not be more than the equivalent of four quarter bends (360 degrees total) between pull points, e.g., conduit bodies and boxes.

**345-12. Supports.** Intermediate metal conduit shall be installed as a complete system as provided in Article 300 and shall be securely fastened in place. Conduit shall be firmly fastened within 3 feet (914 mm) of each outlet box, junction box, cabinet, or fitting. Conduit shall be supported at least every 10 feet (3.05 m).

*Exception No. 1: If made up with threaded couplings, it shall be permissible to support straight runs of intermediate metal conduit in accordance with Table 346-12, provided such supports prevent transmission of stresses to termination where conduit is deflected between supports.*

**345-13. Boxes and Fittings.** See Article 370.

**345-14. Splices and Taps.** Splices and taps shall be made only in junction boxes, outlet boxes or conduit bodies. See Article 370.

**345-15. Bushings.** Where a conduit enters a box, fitting, or other enclosure, a bushing shall be provided to protect the wire from abrasion unless the design of the box, fitting, or enclosure is such as to afford equivalent protection.

(FPN): See Section 373-6(c) for the protection of conductors No. 4 AWG and larger at bushings.

## ARTICLE 346 — RIGID METAL CONDUIT

**346-1. Use.** The use of rigid metal conduit shall be permitted under all atmospheric conditions and occupancies subject to the following:

**(a) Protected by Enamel.** Ferrous raceways and fittings protected from corrosion solely by enamel shall be permitted only indoors and in occupancies not subject to severe corrosive influences.

**(b) Dissimilar Metals.** Where practicable, dissimilar metals in contact anywhere in the system shall be avoided to eliminate the possibility of galvanic action.

*Exception: Aluminum fittings and enclosures shall be permitted to be used with steel rigid metal conduit, and also, steel fittings and enclosures shall be permitted to be used with aluminum rigid metal conduit.*

**(c) Corrosion Protection.** Ferrous or nonferrous metal conduit, elbows, couplings, and fittings shall be permitted to be installed in concrete, in direct contact with the earth, or in areas subject to severe corrosive influences where protected by corrosion protection and judged suitable for the condition.

(FPN): See Section 300-6 for protection against corrosion.

**346-2. Other Articles.** Installations of rigid metal conduit shall comply with the applicable provisions of Article 300.

### A. Installation

**346-3. Cinder Fill.** Conduit shall not be used in or under cinder fill where subject to permanent moisture.

*Exception No. 1: Where of corrosion-resistant material suitable for the purpose.*

*Exception No. 2: Where protected on all sides by a layer of noncinder concrete at least 2 inches (50.8 mm) thick.*

*Exception No. 3: Where the conduit is at least 18 inches (457 mm) under the fill.*

**346-4. Wet Locations.** All supports, bolts, straps, screws, etc., shall be of corrosion-resistant materials or protected against corrosion by corrosion-resistant materials.

(FPN): See Section 300-6 for protection against corrosion.

**346-5. Minimum Size.** Conduit smaller than $\frac{1}{2}$-inch electrical trade size shall not be used.

*Exception No. 1: For underplaster extensions as permitted in Section 344-2 in the NEC.*

*Exception No. 2: For enclosing the leads of motors as permitted in Section 430-145(b) in the NEC.*

**346-6. Number of Conductors in Conduit.** The number of conductors permitted in a single conduit shall not exceed the percentage fill specified in Table 1, Tables and Examples.

(FPN): For conductor cross-sectional area see Tables 5, 5A, 6, 8 and the applicable Notes to Tables at the beginning of Chapter 9.

**346-7. Reaming and Threading.**

**(a) Reamed.** All cut ends of conduits shall be reamed or otherwise finished to remove rough edges.

**(b) Threaded.** Where conduit is threaded in the field, a standard conduit cutting die with a $\frac{3}{4}$-inch (19-mm) taper per foot (305 mm) shall be used.

(FPN): See Standards for Pipe Threads, General Purpose (Inch), ANSI/ASME, B.1.20.1-1983.

**346-8. Bushings.** Where a conduit enters a box, fitting, or other enclosure, a bushing shall be provided to protect the wire from abrasion unless the box, fitting, or enclosure design provides equivalent protection.

(FPN): See Section 373-6(c) for the protection of conductors at bushings.

**346-9. Couplings and Connectors.**

**(a) Threadless.** Threadless couplings and connectors used with conduit shall be made tight. Where buried in masonry or concrete, they shall be of the concretetight type. Where installed in wet locations, they shall be of the raintight type.

**(b) Running Threads.** Running threads shall not be used on conduit for connection at couplings.

**346-10. Bends — How Made.** Bends of rigid metal conduit shall be so made that the conduit will not be damaged, and that the internal diameter of the conduit will not be effectively reduced. The radius of the curve of the inner edge of any field bend shall not be less than shown in Table 346-10.

**Table 346-10.**
**Radius of Conduit Bends (Inches)**

| Size of Conduit (In.) | Conductors Without Lead Sheath (In.) | Conductors With Lead Sheath (In.) |
|---|---|---|
| ½ | 4 | 6 |
| ¾ | 5 | 8 |
| 1 | 6 | 11 |
| 1¼ | 8 | 14 |
| 1½ | 10 | 16 |
| 2 | 12 | 21 |

For SI units: (Radius) one inch = 25.4 millimeters.

*Exception: For field bends for conductors without lead sheath and made with a single operation (one shot) bending machine designed for the purpose, the minimum radius shall not be less than indicated in Table 346-10 Exception.*

**Table 346-10 Exception.**
**Radius of Conduit Bends (Inches)**

| Size of Conduit (In.) | Radius to Center of Conduit (In.) |
|---|---|
| ½ | 4 |
| ¾ | 4½ |
| 1 | 5¾ |
| 1¼ | 7¼ |
| 1½ | 8¼ |
| 2 | 9½ |

For SI units. (Radius) one inch = 25.4 millimeters.

**346-11. Bends — Number in One Run.** There shall not be more than the equivalent of four quarter bends (360 degrees total) between pull points, e.g., conduit bodies and boxes.

**346-12. Supports.** Rigid metal conduit shall be installed as a complete system as provided in Article 300 and shall be securely fastened in place. Conduit shall be firmly fastened within 3 feet (914 mm) of each outlet box, junction box, cabinet, or fitting. Conduit shall be supported at least every 10 feet (3.05 m).

*Exception No. 1: If made up with threaded couplings, it shall be permissible to support straight runs of rigid metal conduit in accordance with Table 346-12, provided such supports prevent transmission of stresses to termination where conduit is deflected between supports.*

**Table 346-12. Supports for Rigid Metal Conduit**

| Conduit Size (Inches) | Maximum Distance Between Rigid Metal Conduit Supports (Feet) |
|---|---|
| ½–¾ | 10 |
| 1 | 12 |
| 1¼–1½ | 14 |
| 2–2½ | 16 |

For SI units: (Supports) one foot = 0.3048 meter.

**346-13. Boxes and Fittings.** Boxes and fittings shall comply with the applicable provisions of Article 370.

**346-14. Splices and Taps.** Splices and taps shall be made only in junction boxes, outlet boxes or conduit bodies. See Article 370.

## ARTICLE 347 — RIGID NONMETALLIC CONDUIT

**347-1. Description.** This article shall apply to a type of conduit and fittings of suitable nonmetallic material that is resistant to moisture and chemical atmospheres. For use aboveground, it shall also be flame-retardant, resistant to impact and crushing, resistant to distortion from heat under conditions likely to be encountered in service, and resistant to low temperature and sunlight effects. For use underground, the material shall be acceptably resistant to moisture and corrosive agents and shall be of sufficient strength to withstand abuse, such as by impact and crushing, in handling and during installation. Where intended for direct burial, without encasement in concrete, the material shall also be capable of withstanding continued loading that is likely to be encountered after installation.

(FPN): Materials that have been recognized as having suitable physical characteristics when properly formed and treated include fiber, asbestos cement, soapstone, rigid polyvinyl chloride, fiberglass epoxy, and high-density polyethylene for underground use, and rigid polyvinyl chloride for use aboveground.

**347-2. Uses Permitted.** The use of rigid nonmetallic conduit and fittings shall be permitted under the following conditions:

(FPN): Extreme cold may cause some nonmetallic conduits to become brittle and therefore more suceptible to damage from physical contact.

**(a) Concealed.** In walls, floors, and ceilings.

**(b) Corrosive Influences.** In locations subject to severe corrosive influences as covered in Section 300-6 and where subject to chemicals for which the materials are specifically approved.

**(c) Cinders.** In cinder fill.

**(d) Wet Locations.** In wet locations, the entire conduit system including boxes and fittings used therewith shall be so installed and equipped as to prevent water from entering the conduit. All supports, bolts, straps, screws, etc., shall be of corrosion-resistant materials or be protected against corrosion by approved corrosion-resistant materials.

**(e) Dry and Damp Locations.** In dry and damp locations not prohibited by Section 347-3.

**(f) Exposed.** For exposed work where not subject to physical damage if identified for such use.

**(g) Underground Installations.** For underground installations, see Section 300-5.

**347-3. Uses Not Permitted.** Rigid nonmetallic conduit shall not be used:

**(b) Support of Fixtures.** For the support of fixtures or other equipment.

**(c) Physical Damage.** Where subject to physical damage unless identified for such use.

**(d) Ambient Temperatures.** Where subject to ambient temperatures exceeding those for which the conduit is approved.

**(e) Insulation Temperature Limitations.** For conductors whose insulation temperature limitations would exceed those for which the conduit is approved.

**347-4. Other Articles.** Installation of rigid nonmetallic conduit shall comply with the applicable provisions of Article 300. Where equipment grounding is required by Article 250, a separate equipment grounding conductor shall be installed in the conduit.

### A. Installations

**347-5. Trimming.** All cut ends shall be trimmed inside and outside to remove rough edges.

**347-6. Joints.** All joints between lengths of conduit, and between conduit and couplings, fittings, and boxes, shall be made by an approved method.

**347-8. Supports.** Rigid nonmetallic conduit shall be secured as required by Table 347-8. In addition, conduit shall be securely fastened within 3 feet (914 mm) of each box, cabinet, or other conduit termination.

**Table 347-8. Support of Rigid Nonmetallic Conduit**

| Conduit Size (Inches) | Maximum Spacing Between Supports (Feet) |
|---|---|
| ½-1 | 3 |
| 1¼-2 | 5 |

For SI units: (Supports) one foot = 0.3048 meter.

**347-9. Expansion Joints.** Expansion joints for rigid nonmetallic conduit shall be provided to compensate for thermal expansion and contraction.

**347-10. Minimum Size.** No conduit smaller than ½-inch electrical trade size shall be used.

**347-11. Number of Conductors.** The number of conductors permitted in a single conduit shall not exceed the percentage fill specified in Table 1 in Tables and Examples.

(FPN): For conductor cross-sectional area see Tables 5, 5A, 6, 8 and the applicable Notes to Tables at the beginning of Tables and Examples.

**347-12. Bushings.** Where a conduit enters a box or other fitting, a bushing or adapter shall be provided to protect the wire from abrasion unless the design of the box or fitting is such as to provide equivalent protection.

(FPN): See Section 373-6(c) for the protection of conductors No. 4 AWG and larger at bushings.

**347-13. Bends — How Made.** Bends of rigid nonmetallic conduit shall be so made that the conduit will not be damaged and that the internal diameter of the conduit will not be effectively reduced. Field bends shall be made only with bending equipment identified for the purpose, and the radius of the curve of the inner edge of such bends shall not be less than shown in Table 346-10.

**347-14. Bends — Number in One Run.** There shall not be more than the equivalent of four quarter bends (360 degrees total) between pull points, e.g., conduit bodies and boxes.

**347-15. Boxes and Fittings.** Boxes and fittings shall comply with the applicable provisions of Article 370.

**347-16. Splices and Taps.** Splices and taps shall be made only in junction boxes, outlet boxes or conduit bodies. See Article 370.

## ARTICLE 348 — ELECTRICAL METALLIC TUBING

**348-1. Use.** The use of electrical metallic tubing shall be permitted for both exposed and concealed work. Electrical metallic tubing shall not be used: (1) where, during installation or afterward, it will be subject to severe physical damage; (2) where protected from corrosion solely by enamel; (3) in cinder concrete or cinder fill where subject to permanent moisture unless protected on all sides by a layer of noncinder concrete at least 2 inches (50.8 mm) thick or unless the tubing is at least 18 inches (457 mm) under the fill. Where practicable, dissimilar metals in contact anywhere in the system shall be avoided to eliminate the possibility of galvanic action.

*Exception: Aluminum fittings and enclosures shall be permitted to be used with steel electrical metallic tubing.*

Ferrous or nonferrous electrical metallic tubing, elbows, couplings, and fittings shall be permitted to be installed in concrete, in direct contact with the earth, or in areas subject to severe corrosive influences when protected by corrosion protection and judged suitable for the condition.

(FPN): See Section 300-6 for protection against corrosion.

**348-2. Other Articles.** Installations of electrical metallic tubing shall comply with the applicable provisions of Article 300.

### A. Installation

**348-4. Wet Locations.** All supports, bolts, straps, screws, etc., shall be of corrosion-resistant materials or protected against corrosion by corrosion-resistant materials.

(FPN): See Section 300-6 for protection against corrosion.

**348-5. Size.**

**(a) Minimum.** Tubing smaller than 1/2-inch electrical trade size shall not be used.

*Exception No. 1: For underplaster extensions as permitted in Section 344-2 in the NEC.*

*Exception No. 2: For enclosing the leads of motors as permitted in Section 430-145(b) in the NEC.*

**(b) Maximum.** The maximum size of tubing shall be the 4-inch electrical trade size.

**348-6. Number of Conductors in Tubing.** The number of conductors permitted in a single tubing shall not exceed the percentage fill specified in Table 1 in Tables and Examples.

(FPN): For conductor cross-sectional area see Tables 5, 5A, 6, 8 and the applicable Notes to Tables at the beginning of Tables and Examples.

**348-7. Threads.** Electrical metallic tubing shall not be threaded. Where integral couplings are utilized, such couplings shall be permitted to be factory threaded.

**348-8. Couplings and Connectors.** Couplings and connectors used with tubing shall be made up tight. Where buried in masonry or concrete, they shall be concretetight type. Where installed in wet locations, they shall be of the raintight type.

**348-9. Bends — How Made.** Bends in the tubing shall be so made that the tubing will not be damaged and that the internal diameter of the tubing will not be effectively reduced. The radius of the curve of the inner edge of any field bend shall not be less than shown in Table 346-10.

*Exception: For field bends made with a bending machine designed for the purpose, the minimum radius shall not be less than indicated in Table 346-10 Exception.*

**348-10. Bends — Number in One Run.** There shall not be more than the equivalent of four quarter bends (360 degrees total) between pull points, e.g., conduit bodies and boxes.

**348-11. Reaming.** All cut ends of electrical metallic tubing shall be reamed or otherwise finished to remove rough edges.

**348-12. Supports.** Electrical metallic tubing shall be installed as a complete system as provided in Article 300 and shall be securely fastened in place at least every 10 feet (3.05 m) and within 3 feet (914 mm) of each outlet box, junction box, cabinet, or fitting.

*Exception: Unbroken lengths of electrical metallic tubing shall be permitted to be supported at distances not more than 5 feet (1.52 m) from each outlet box or fitting where structural members do not readily permit support within 3 feet (914 mm).*

**348-13. Boxes and Fittings.** Boxes and fittings shall comply with the applicable provisions of Article 370.

**348-14. Splices and Taps.** Splices and taps shall be made only in junction boxes, outlet boxes or conduit bodies. See Article 370.

# ARTICLE 350 — FLEXIBLE METAL CONDUIT

**350-1. Other Articles.** Installations of flexible metal conduit shall comply with the applicable provisions of Article 300.

**350-2. Use.** Flexible metal conduit shall not be used: (1) in wet locations unless conductors are of lead-covered type or of other types approved for the specific conditions and the installation is such that water is not likely to enter other raceways or enclosures to which the conduit is connected; nor (6) underground or embedded in poured concrete or aggregate.

**350-3. Minimum Size.** Flexible metal conduit less than 1/2-inch electrical trade size shall not be used.

*Exception No. 3: Flexible metal conduit of 3/8-inch nominal trade size shall be permitted in lengths not in excess of 6 feet (1.83 m) as a part of a listed assembly, or for tap connections to lighting fixtures as required in Section 410-67(c), or for utilization equipment.*

*Exception No. 4: Flexible metal conduit of 3/8-inch nominal trade size shall be permitted for manufactured wiring systems as permitted in Section 604-6(a) in the NEC.*

*Exception No. 5: As permitted in Section 620-21, Exception No. 5 in the NEC.*

**Table 350-3. Maximum Number of Insulated Conductors in ⅜-Inch Flexible Metal Conduit ***

**Col. A = With fitting inside conduit.**
**Col. B = With fitting outside conduit.**

| Size AWG | Types RFH-2, SF-2 | | Types TF, XHHW, AF, TW | | Types TFN, THHN, THWN | | Types FEP, FEPB, PF, PGF | |
|---|---|---|---|---|---|---|---|---|
| | A | B | A | B | A | B | A | B |
| 18 | .. | 3 | 3 | 7 | 4 | 8 | 5 | 8 |
| 16 | .. | 2 | 2 | 4 | 3 | 7 | 4 | 8 |
| 14 | .. | .. | .. | 4 | 3 | 7 | 3 | 7 |
| 12 | .. | .. | .. | 3 | .. | 4 | .. | 4 |
| 10 | .. | .. | .. | .. | .. | 2 | .. | 3 |

* In addition, one uninsulated equipment grounding conductor of the same size shall be permitted.

**350-4. Supports.** Flexible metal conduit shall be secured by an approved means at intervals not exceeding 4 1/2 feet (1.37 m) and within 12 inches (305 mm) on each side of every outlet box, junction box, cabinet, or fitting.

*Exception No. 1: Where flexible metal conduit is fished.*

*Exception No. 2: Lengths not exceeding 3 feet (914 mm) at terminals where flexibility is necessary.*

*Exception No. 3: Lengths not exceeding 6 feet (1.83 m) from a fixture terminal connection for tap connections to lighting fixtures as required in Section 410-67(c).*

**350-5. Grounding.** Flexible metal conduit shall be permitted as a grounding means as covered in Section 250-91(b). Where an equipment bonding jumper is required around flexible metal conduit, it shall be installed in accordance with Section 250-79.

*Exception No. 1: Where used to connect equipment where flexibility is required, a grounding conductor shall be installed.*

*Exception No. 2: Flexible metal conduit shall be permitted as a grounding means if the total length in any ground return path is 6 feet (1.83 m) or less, the conduit is terminated in fittings listed for grounding, and the circuit conductors contained therein are protected by overcurrent devices rated at 20 amperes or less.*

**350-6. Bends — Number in One Run.** There shall not be more than the equivalent of four quarter bends (360 degrees total) between pull points, e.g., conduit bodies and boxes.

Angle connectors shall not be used for concealed raceway installations.

**350-7. Number of Conductors.** The number of conductors permitted in a single $\frac{1}{2}$-inch through 4-inch trade size, shall not exceed the percentage of fill specified in Table 1, in Tables and Examples. See Table 350-3 for $\frac{3}{8}$-inch flexible-metal conduit.

**350-8. Fittings.** Fittings listed for flexible metal conduit shall be used.

## ARTICLE 351 — LIQUIDTIGHT FLEXIBLE METAL CONDUIT AND LIQUIDTIGHT FLEXIBLE NONMETALLIC CONDUIT

**351-1. Scope.** This article covers liquidtight flexible metal conduit and liquidtight flexible nonmetallic conduit.

### A. Liquidtight Flexible Metal Conduit

**351-2. Definition.** Liquidtight flexible metal conduit is 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 and approved for the installation of electric conductors.

**351-3. Other Articles.** Installations of liquidtight flexible metal conduit shall comply with the applicable provisions of Article 300 and with the specific sections of Article 350.

(FPN): For marking requirements, see Section 110-21.

**351-4. Use.**

**(a) Permitted.** The use of listed and marked liquidtight flexible metal conduit shall be permitted for direct burial in earth and for exposed and concealed work.

**(b) Not Permitted.** Liquidtight flexible metal conduit shall not be used:

(1) Where subject to physical damage.

(2) Where any combination of ambient and/or conductor temperature will produce an operating temperature in excess of that for which the material is approved.

### 351-5. Size.

**(a) Minimum.** Liquidtight flexible metal conduit smaller than 1/2-inch electrical trade size shall not be used.

*Exception: 3/8-inch size shall be permitted as covered in Section 350-3.*

**(b) Maximum.** The maximum size of liquidtight flexible metal conduit shall be the 4-inch trade size.

### 351-6. Number of Conductors.

**(a) Single Conduit.** The number of conductors permitted in a single conduit, 1/2- through 4-inch trade sizes, shall not exceed the percentage of fill specified in Table 1 of Tables and Examples.

**(b) 3/8-Inch Liquidtight Flexible Metal Conduit.** The number of conductors permitted in 3/8-inch liquidtight flexible metal conduit shall not exceed that permitted in Table 350-3.

**351-7. Fittings.** Liquidtight flexible metal conduit shall be used only with approved terminal fittings.

**351-8. Supports.** Where liquidtight flexible metal conduit is installed as a fixed raceway, it shall be secured at intervals not exceeding 4 1/2 feet (1.37 m) and within 12 inches (305 mm) on each side of every outlet box, junction box, cabinet, or fitting.

*Exception No. 1: Where liquidtight flexible metal conduit is fished.*

*Exception No. 2: Lengths not exceeding 3 feet (914 mm) at terminals where flexibility is necessary.*

*Exception No. 3: Lengths not exceeding 6 feet (1.83 m) from a fixture terminal connection for tap conductors to lighting fixtures as required in Section 410-67(c).*

**351-9. Grounding.** Liquidtight flexible metal conduit shall be permitted as a grounding conductor where both the conduit and the fittings are approved for grounding. Where an equipment bonding jumper is required around liquidtight flexible metal conduit, it shall be installed in accordance with Section 250-79.

*Exception No. 1: When used to connect equipment where flexibility is required, an equipment grounding conductor shall be installed.*

*Exception No. 2: Liquidtight flexible metal conduit shall be permitted as a grounding means in the 1 1/4-inch and smaller trade sizes if the total length of all liquidtight flexible metal conduit in any ground return path is 6 feet (1.83 m) or less, the conduit is terminated in fittings listed for grounding, and the circuit conductors contained therein are protected by overcurrent devices rated at 20 amperes or less for 3/8-inch and 1/2-inch trade sizes and 60 amperes or less for 3/4-inch through 1 1/4-inch trade sizes.*

**351-10. Bends — Number in One Run.** There shall not be more than the equivalent of four quarter bends (360 degrees total) between pull points, e.g., conduit bodies and boxes.

Angle connectors shall not be used for concealed raceway installations.

### B. Liquidtight Flexible Nonmetallic Conduit

**351-22. Definition.** Liquidtight flexible nonmetallic conduit is a raceway of circular cross section of various types:

(1) A smooth seamless inner core and cover bonded together and having one or more reinforcement layers between the core and cover.

(2) A smooth inner surface with integral reinforcement within the conduit wall.

(3) A corrugated internal and external surface without integral reinforcement within the conduit wall.

This conduit is flame-resistant and, with fittings, is approved for the installation of electrical conductors.

**351-23. Use.**

**(a) Permitted.** Liquidtight flexible nonmetallic conduit shall be permitted to be used in exposed or concealed locations:

(FPN): Extreme cold may cause some types of nonmetallic conduits to become brittle and therefore more susceptible to damage from physical contact.

(1) Where flexibility is required for installation, operation, or maintenance;

(2) Where protection of the contained conductors is required from vapors, liquids, or solids;

(3) For outdoor locations where listed and marked as suitable for the purpose.

(FPN): For marking requirements, see Section 110-21.

(4) For direct burial where listed and marked for the purpose.

**(b) Not Permitted.** Liquidtight flexible nonmetallic conduit shall not be used:

(1) Where subject to physical damage;

(2) Where any combination of ambient and conductor temperatures is in excess of that for which the liquidtight flexible nonmetallic conduit is approved;

**(3)** In lengths longer than 6 feet (1.83 m);

*Exception: Where approved for special installations.*

**(4)** Where voltage of the contained conductors is in excess of 600 volts, nominal.

**351-24. Size.** The sizes of liquidtight flexible nonmetallic conduit shall be electrical trade sizes $\frac{1}{2}$ inch to 4 inch inclusive.

*Exception: $\frac{3}{8}$-inch size for enclosing the leads of motors as permitted in Section 430-145(b) of the NEC.*

**351-25. Number of Conductors.** The number of conductors permitted in a single conduit shall be in accordance with the percentage fill specified in Table 1 in Tables and Examples.

**351-26. Fittings.** Liquidtight flexible nonmetallic conduit shall be used only with terminal fittings identified for such use.

**351-27. Equipment Grounding.** Where an equipment grounding conductor is required for the circuits installed in liquidtight flexible nonmetallic conduit, it shall be permitted to be installed on the inside or outside of the conduit. Where installed on the outside, the length of the equipment grounding conductor shall not exceed 6 feet (1.83 m) and shall be routed with the raceway or enclosure. Fittings and boxes shall be bonded or grounded in accordance with Article 250.

## ARTICLE 353 — MULTIOUTLET ASSEMBLY

**353-1. Other Articles.** A multioutlet assembly shall comply with applicable provisions of Article 300.

(FPN): See definition in Article 100.

**353-2. Use.** The use of multioutlet assembly shall be permitted in dry locations. It shall not be installed: (1) where concealed, except that it shall be permissible to surround the back and sides of a metal multioutlet assembly by the building finish or recess a nonmetallic multioutlet assembly in a baseboard; (2) where subject to severe physical damage; (3) where the voltage is 300 volts or more between conductors unless the assembly is of metal having a thickness of not less than .040 inch (1.02 mm); (4) where subject to corrosive vapors; (5) in hoistways; nor (6) in any hazardous (classified) locations except Class I, Division 2 locations as permitted in the Exception to Section 501-4(b).

**353-3. Metal Multioutlet Assembly Through Dry Partitions.** It shall be permissible to extend a metal multioutlet assembly through (not run within) dry partitions, if arrangements are made for removing the cap or cover on all exposed portions and no outlet is located within the partitions.

# ARTICLE 370 — OUTLET, DEVICE, PULL AND JUNCTION BOXES, CONDUIT BODIES AND FITTINGS

## A. Scope and General

**370-1. Scope.** This article covers the installation and use of all boxes, conduit bodies, and fittings as required by Section 300-15, and boxes, conduit bodies, and fittings referred to in Section 300-15 used as outlet, junction, or pull boxes, depending on their use. Cast, sheet metal, nonmetallic, and other boxes such as FS, FD, and larger boxes are not classified as conduit bodies. Fittings such as capped elbows and service-entrance elbows are not classified as conduit bodies.

(FPN): For systems over 600 volts, nominal, see Part D of this article in the NEC.

**370-2. Round Boxes.** Round boxes shall not be used where conduits or connectors requiring the use of locknuts or bushings are to be connected to the side of the box.

**370-3. Nonmetallic Boxes.** Nonmetallic boxes shall be permitted only with open wiring on insulators, concealed knob-and-tube wiring, nonmetallic-sheathed cable, and nonmetallic raceways.

*Exception No. 1: Where internal bonding means are provided between all entries, nonmetallic boxes shall be permitted to be used with metal raceways or metal-jacketed cables.*

*Exception No. 2: Where integral bonding means with a provision for attaching a grounding jumper inside the box are provided between all threaded entries in nonmetallic boxes listed for the purpose, nonmetallic boxes shall be permitted to be used with metal raceways or metal-jacketed cables.*

**370-4. Metal Boxes.** All metal boxes shall be grounded in accordance with the provisions of Article 250.

## B. Installation

**370-5. Damp or Wet Locations.**

**(a) Damp or Wet Locations.** In damp or wet locations, boxes, conduit bodies, and fittings shall be so placed or equipped as to prevent moisture from entering or accumulating within the box, conduit body, or fitting. Boxes, conduit bodies, and fittings installed in wet locations shall be listed for use in wet locations.

**370-6. Number of Conductors in Outlet, Device, and Junction Boxes, and Conduit Bodies.** Boxes shall be of sufficient size to provide free space for all conductors enclosed in the box.

The provisions of this section shall not apply to terminal housings supplied with motors. See Section 430-12 in the NEC.

Boxes and conduit bodies containing conductors, size No. 4 or larger, shall also comply with the provisions of Section 370-18.

**(a) Standard Boxes.** The maximum number of conductors permitted in standard boxes shall be as is listed in Table 370-6(a). See Section 370-18 where boxes or conduit bodies are used as junction or pull boxes.

**Table 370-6(a). Metal Boxes**

| Box Dimension, Inches Trade Size or Type | Min. Cu. In. Cap. | Maximum Number of Conductors No. 18 | No. 16 | No. 14 | No. 12 | No. 10 | No. 8 | No. 6 |
|---|---|---|---|---|---|---|---|---|
| 4 x 1¼ Round or Octagonal | 12.5 | 8 | 7 | 6 | 5 | 5 | 4 | 2 |
| 4 x 1½ Round or Octagonal | 15.5 | 10 | 8 | 7 | 6 | 6 | 5 | 3 |
| 4 x 2⅛ Round or Octagonal | 21.5 | 14 | 12 | 10 | 9 | 8 | 7 | 4 |
| 4 x 1¼ Square | 18.0 | 12 | 10 | 9 | 8 | 7 | 6 | 3 |
| 4 x 1½ Square | 21.0 | 14 | 12 | 10 | 9 | 8 | 7 | 4 |
| 4 x 2⅛ Square | 30.3 | 20 | 17 | 15 | 13 | 12 | 10 | 6 |
| 4 11/16 x 1¼ Square | 25.5 | 17 | 14 | 12 | 11 | 10 | 8 | 5 |
| 4 11/16 x 1½ Square | 29.5 | 19 | 16 | 14 | 13 | 11 | 9 | 5 |
| 4 11/16 x 2⅛ Square | 42.0 | 28 | 24 | 21 | 18 | 16 | 14 | 8 |
| 3 x 2 x 1½ Device | 7.5 | 5 | 4 | 3 | 3 | 3 | 2 | 1 |
| 3 x 2 x 2 Device | 10.0 | 6 | 5 | 5 | 4 | 4 | 3 | 2 |
| 3 x 2 x 2¼ Device | 10.5 | 7 | 6 | 5 | 4 | 4 | 3 | 2 |
| 3 x 2 x 2½ Device | 12.5 | 8 | 7 | 6 | 5 | 5 | 4 | 2 |
| 3 x 2 x 2¾ Device | 14.0 | 9 | 8 | 7 | 6 | 5 | 4 | 2 |
| 3 x 2 x 3½ Device | 18.0 | 12 | 10 | 9 | 8 | 7 | 6 | 3 |
| 4 x 2⅛ x 1½ Device | 10.3 | 6 | 5 | 5 | 4 | 4 | 3 | 2 |
| 4 x 2⅛ x 1⅞ Device | 13.0 | 8 | 7 | 6 | 5 | 5 | 4 | 2 |
| 4 x 2⅛ x 2⅛ Device | 14.5 | 9 | 8 | 7 | 6 | 5 | 4 | 2 |
| 3¾ x 2 x 2½ Masonry Box/Gang | 14.0 | 9 | 8 | 7 | 6 | 5 | 4 | 2 |
| 3¾ x 2 x 3½ Masonry Box/Gang | 21.0 | 14 | 12 | 10 | 9 | 8 | 7 | 4 |
| FS—Minimum Internal Depth 1¾ Single Cover/Gang | 13.5 | 9 | 7 | 6 | 6 | 5 | 4 | 2 |
| FD—Minimum Internal Depth 2⅜ Single Cover/Gang | 18.0 | 12 | 10 | 9 | 8 | 7 | 6 | 3 |
| FS—Minimum Internal Depth 1¾ Multiple Cover/Gang | 18.0 | 12 | 10 | 9 | 8 | 7 | 6 | 3 |
| FD—Minimum Internal Depth 2⅜ Multiple Cover/Gang | 24.0 | 16 | 13 | 12 | 10 | 9 | 8 | 4 |

**(1)** Table 370-6(a) shall apply where no fittings or devices, such as fixture studs, cable clamps, hickeys, switches, or receptacles, are contained in the box and where no grounding conductors are part of the wiring within the box. Where one or more of these types of fittings, such as fixture studs, cable clamps, or hickeys are contained in the box, the number of conductors shown in the table shall be reduced by one for each type of fitting; an additional deduction of two conductors shall be made for each mounting yoke or strap containing one or more devices; and a further deduction of one conductor shall be made for one or more grounding conductors entering the box. Where a second set of equipment grounding conductors, as permitted by Section 250-74, Exception No. 4 in the NEC, is present in the box, then an additional deduction of one conductor shall be made. A conductor running through the box shall be counted as one conductor, and each conductor originating outside of the box and terminating inside the box is counted as one conductor. Conductors, no part of which leaves the box, shall not be counted. The volume of a wiring enclosure (box) shall be the total volume of the assembled sections, and, where used, the space pro-

vided by plaster rings, domed covers, extension rings, etc., that are marked with their volume in cubic inches, or are made from boxes the dimensions of which are listed in Table 370-6(a).

(2) For combinations of conductor sizes shown in Table 370-6(a), the maximum number of conductors permitted shall be computed using the volume per conductor listed in Table 370-6(b), with the deductions provided for in Section 370-6(a)(1) and these volume deductions shall be based on the largest conductor entering the box. The maximum number and size of conductors listed in Table 370-6(a) shall not be exceeded.

**(b) Other Boxes.** Boxes 100 cubic inches or less other than those described in Table 370-6(a), conduit bodies having provision for more than two conduit entries and nonmetallic boxes shall be durably and legibly marked by the manufacturer with their cubic inch capacity. The maximum number of conductors permitted shall be computed using the volume per conductor listed in Table 370-6(b), with the deductions provided for in Section 370-6(a)(1), and these volume deductions shall be based on the largest conductor entering the box. Boxes described in Table 370-6(a) that have a larger cubic inch capacity than is designated in the table shall be permitted to have their cubic inch capacity marked as required by this section and the maximum number of conductors permitted shall be computed using the volume per conductor listed in Table 370-6(b).

**Table 370-6(b). Volume Required per Conductor**

| Size of Conductor | Free Space Within Box for Each Conductor |
|---|---|
| No. 18 | 1.5 cubic inches |
| No. 16 | 1.75 cubic inches |
| No. 14 | 2. cubic inches |
| No. 12 | 2.25 cubic inches |
| No. 10 | 2.5 cubic inches |
| No. 8 | 3. cubic inches |
| No. 6 | 5. cubic inches |

**(c) Conduit Bodies.** Conduit bodies enclosing No. 6 conductors or smaller shall have a cross-sectional area not less than twice the cross-sectional area of the largest conduit or tubing to which it is attached. The maximum number of conductors permitted shall be the maximum number permitted by Table 1, Tables and Examples, for the conduit to which it is attached.

Conduit bodies having provisions for less than three conduit entries shall not contain splices, taps, or devices unless they comply with the provisions of Section 370-6(b) and are supported in a rigid and secure manner.

**370-7. Conductors Entering Boxes, Conduit Bodies, or Fittings.** Conductors entering boxes, conduit bodies or fittings shall be protected from abrasion, and shall comply with (a) through (d) below.

**(a) Openings to Be Closed.** Openings through which conductors enter shall be adequately closed.

**(b) Metal Boxes, Conduit Bodies, and Fittings.** Where metal outlet boxes, conduit bodies or fittings are installed with open wiring or concealed

knob-and-tube wiring, conductors shall enter through insulating bushings or, in dry locations, through flexible tubing extending from the last insulating support and firmly secured to the box, conduit body or fitting. Where raceway or cable is installed with metal outlet boxes, conduit bodies or fittings, the raceway or cable shall be secured to such boxes, conduit bodies and fittings. Fittings such as capped elbows and service-entrance elbows shall not contain splices, taps, or devices and shall be of sufficient size to provide free space for all conductors enclosed in the fitting.

**(c) Nonmetallic Boxes.** Nonmetallic boxes shall be suitable for the lowest temperature rated conductor entering the box. Where nonmetallic boxes are used with open wiring or concealed knob-and-tube wiring, the conductors shall enter the box through individual holes. Where flexible tubing is used to encase the conductors, the tubing shall extend from the last insulating support to no less than 1/4 inch (6.35 mm) inside the box. Where nonmetallic-sheathed cable is used, the cable assembly, including the sheath, shall extend into the box no less than 1/4 inch (6.35 mm) through a nonmetallic-sheathed cable knockout opening. In all instances all permitted wiring methods shall be secured to the boxes.

*Exception: Where nonmetallic-sheathed cable is used with boxes no larger than a nominal size 2 1/4 inch by 4 inch mounted in walls and where the cable is fastened within 8 inches (203 mm) of the box measured along the sheath and where the sheath extends into the box no less than 1/4 inch (6.35 mm), securing the cable to the box shall not be required.*

**(d) Conductors No. 4 AWG or Larger.** Installation shall comply with Section 373-6(c).

**370-8. Unused Openings.** Unused openings in boxes, conduit bodies and fittings shall be effectively closed to afford protection substantially equivalent to that of the wall of the box, conduit body or fitting. Metal plugs or plates used with nonmetallic boxes, conduit bodies or fittings shall be recessed at least 1/4 inch (6.35 mm) from the outer surface.

**370-9. Boxes Enclosing Flush Devices.** Boxes used to enclose flush devices shall be of such design that the devices will be completely enclosed on back and sides, and that substantial support for the devices will be provided. Screws for supporting the box shall not be used in attachment of the device contained therein.

**370-10. In Wall or Ceiling.** In walls or ceilings of concrete, tile, or other noncombustible material, boxes and fittings shall be so installed that the front edge of the box or fitting will not set back of the finished surface more than 1/4 inch (6.35 mm). In walls and ceilings constructed of wood or other combustible material, outlet boxes and fittings shall be flush with the finished surface or project therefrom.

**370-11. Repairing Plaster and Drywall or Plasterboard.** Plaster, drywall or plasterboard surfaces that are broken or incomplete shall be repaired so there will be no gaps or open spaces greater than 1/8 inch (3.18 mm) at the edge of the box or fitting.

**370-12. Exposed Surface Extensions.** Surface extensions from an outlet box of a concealed wiring system shall be made by mounting and mechanically securing a box or extension ring over the concealed box. Where required, equipment grounding shall be in accordance with Article 250.

*Exception: A surface extension shall be permitted to be made from a concealed box cover where the cover is designed so that it cannot fall off, or be removed if its security means becomes loose, and if the wiring method is flexible and so arranged that any required grounding continuity is independent of the connection between the box and cover.*

**370-13. Supports.** Enclosures within the scope of Article 370 shall be rigidly and securely fastened in place in accordance with (a) through (h) below.

**(a) Surface Mounting.** They shall be fastened to the surface upon which they are mounted unless such surface does not provide adequate support in which case they shall be supported in accordance with (b).

**(b) Structural Mounting.** They shall be rigidly supported from a structural member of the building either directly or by using a metal or wood brace. Support wires that do not provide rigid support shall not be permitted as the sole support.

(1) Nails, where used as a fastening means, shall be permitted to pass through the interior of the enclosure if located within 1/4 inch (6.35 mm) of the back or ends of the enclosure.

(2) Metal braces shall be protected against corrosion and formed from metal not less than .020 inch (508 micrometers) thick uncoated. Wood braces shall have a cross section not less than nominal 1 inch (25.4 mm) by 2 inches (50.8 mm).

**(c) Nonstructural Mounting.** It shall be permissible to make a flush installation in existing covered surfaces where adequate support is provided by clamps, anchors, or fittings. Framing members of suspended ceiling systems shall be permitted as the support if the framing members are adequately supported and securely fastened to each other and to the building structure. Enclosures so supported shall be fastened to the framing member by mechanical means such as bolts, screws, or rivets. Clips identified for use with the type of ceiling framing member(s) and enclosure(s) shall also be permitted.

**(d) Raceway Supported Enclosure(s), Without Devices or Fixtures.** Threaded enclosures not over 100 cubic inches (1640 $cm^3$) that do not contain devices, receptacles, or switches and do not support fixtures shall be considered to be adequately supported if two or more conduits are threaded wrenchtight into the enclosure or into hubs identified for the purpose and the conduits are supported within 3 feet (914 mm) of the enclosure on two or more sides so as to provide the rigid and secure installation intended by this section of the Code.

*Exception: Conduit or electrical metallic tubing shall be permitted to support conduit bodies provided the conduit bodies are not larger than the largest trade size of the conduit or electrical metallic tubing.*

Such enclosures shall also be considered to be adequately supported if they comply with subsection (e) following.

**(e) Raceway Supported Enclosures, With Devices or Fixtures.** Threaded enclosures not over 100 cubic inches (1640 $cm^3$) that contain devices, receptacles, switches, or support fixtures shall be adequately supported if two or more conduits are threaded wrenchtight into the enclosure or into hubs identified for the purpose and if each conduit is supported

within 18 inches (457 mm) of the enclosure so as to provide the rigid and secure installation intended by this section of the Code.

*Exception: Conduit shall be permitted to support conduit bodies provided the conduit bodies are not larger than the largest trade size of the conduit.*

**(f) Enclosure(s) in Concrete or Masonry.** Enclosure(s) shall be permitted to be supported by being embedded.

**(g) Nonthreaded Nonmetallic Enclosures, Metal Conduit Supported.** Nonthreaded nonmetallic enclosures shall be permitted to be installed in accordance with instructions contained in the listing or labeling provided the two or more conduit support distances comply with (d) or (e) above.

**(h) Pendant Boxes.** Boxes shall be supported from a multiconductor cord or cable in an approved manner that protects the conductors against strain, such as a strain relief connector threaded into a box with a hub.

**370-14. Depth of Outlet Boxes.** No box shall have an internal depth of less than $\frac{1}{2}$ inch (12.7 mm). Boxes intended to enclose flush devices shall have an internal depth of not less than $\frac{15}{16}$ inch (23.8 mm).

**370-15. Covers and Canopies.** In completed installations each outlet box shall have a cover, faceplate, or fixture canopy.

**(a) Nonmetallic or Metal Covers and Plates.** Nonmetallic or metal covers and plates shall be permitted with nonmetallic outlet boxes. Where metal covers or plates are used, they shall comply with the grounding requirements of Section 250-42.

(FPN): See Sections 410-18(a) and 410-56(c) for metal faceplates.

**(b) Exposed Combustible Wall or Ceiling Finish.** Where a fixture canopy or pan is used, any combustible wall or ceiling finish exposed between the edge of the canopy or pan and the outlet box shall be covered with noncombustible material.

**(c) Flexible Cord Pendants.** Covers of outlet boxes and conduit bodies having holes through which flexible cord pendants pass shall be provided with bushings designed for the purpose or shall have smooth, well-rounded surfaces on which the cords may bear. So-called hard-rubber or composition bushings shall not be used.

**370-17. Outlet Boxes.**

**(a) Boxes at Lighting Fixture Outlets.** Boxes used at lighting fixture outlets shall be designed for the purpose. At every outlet used exclusively for lighting, the box shall be so designed or installed that a lighting fixture may be attached.

**(b) Floor Boxes.** Boxes listed specifically for this application shall be used for receptacles located in the floor.

*Exception: Boxes located in elevated floors of show windows and similar locations where the authority having jurisdiction judges them to be free from physical damage, moisture, and dirt.*

**(c) Boxes at Fan Outlets.** Outlet boxes shall not be used as the sole support for ceiling (paddle) fans.

*Exception: Boxes listed for the application shall be permitted as the sole means of support.*

**370-18. Pull and Junction Boxes.** Boxes and conduit bodies used as pull or junction boxes shall comply with (a) through (d) of this section.

**(a) Minimum Size.** For raceways 3/4-inch trade size or larger, containing conductors of No. 4 or larger, and for cables containing conductors of No. 4 or larger, the minimum dimensions of pull or junction boxes installed in a raceway or cable run shall comply with the following:

**(1) Straight Pulls.** In straight pulls the length of the box shall not be less than eight times the trade diameter of the largest raceway.

**(2) Angle or U Pulls.** Where angle or U pulls are made, the distance between each raceway entry inside the box and the opposite wall of the box shall not be less than six times the trade diameter of the largest raceway in a row. This distance shall be increased for additional entries by the amount of the sum of the diameters of all other raceway entries in the same row on the same wall of the box. Each row shall be calculated individually, and the single row that provides the maximum distance shall be used.

*Exception: Where a raceway or cable entry is in the wall of a box or conduit body opposite to a removable cover and where the distance from that wall to the cover is in conformance with the column for one wire per terminal in Table 373-6(a).*

The distance between raceway entries enclosing the same conductor shall not be less than six times the trade diameter of the larger raceway.

When transposing cable size into raceway size in (a)(1) and (a)(2) above, the minimum trade size raceway required for the number and size of conductors in the cable shall be used.

**(3)** Boxes of dimensions less than those required in (a)(1) and (a)(2) above shall be permitted for installations of combinations of conductors that are less than the maximum conduit or tubing fill (of conduits or tubing being used) permitted by Table 1, Tables and Examples, provided the box has been approved for and is permanently marked with the maximum number and maximum size of conductors permitted.

*Exception: Terminal housings supplied with motors which shall comply with the provisions of Section 430-12 in the NEC.*

**(c) Covers.** All pull boxes, junction boxes, conduit bodies, and fittings shall be provided with covers compatible with the box, conduit body or fitting construction and suitable for the conditions of use. Where metal covers are used, they shall comply with the grounding requirements of Section 250-42.

**(d) Permanent Barriers.** Where permanent barriers are installed in a box, each section shall be considered as a separate box.

**370-19. Conduit Bodies, Junction, Pull and Outlet Boxes to Be Accessible.** Conduit bodies, junction, pull and outlet boxes shall be so installed that the wiring contained in them can be rendered accessible without removing any part of the building or in underground circuits without excavating sidewalks, paving, earth, or other substance that is to be used to establish the finished grade.

*Exception: Listed boxes shall be permitted where covered by gravel, light aggregate, or noncohesive granulated soil if their location is effectively identified and accessible for excavation.*

# ARTICLE 373 — CABINETS AND CUTOUT BOXES

**373-1. Scope.** This article covers the installation and construction specifications of cabinets, cutout boxes, and meter socket enclosures.

## A. Installation

**373-2. Damp or Wet Locations.**

**(a) Damp and Wet Locations.** In damp or wet locations, cabinets and cutout boxes of the surface type shall be so placed or equipped as to prevent moisture or water from entering and accumulating within the cabinet or cutout box, and shall be mounted so there is at least 1/4-inch (6.35-mm) air space between the enclosure and the wall or other supporting surface. Cabinets or cutout boxes installed in wet locations shall be weatherproof.

(FPN): For protection against corrosion, see Section 300-6.

**373-3. Position in Wall.** In walls of concrete, tile, or other noncombustible material, cabinets shall be so installed that the front edge of the cabinet will not set back of the finished surface more than 1/4 inch (6.35 mm). In walls constructed of wood or other combustible material, cabinets shall be flush with the finished surface or project therefrom.

**373-4. Unused Openings.** Unused openings in cabinet or cutout boxes shall be effectively closed to afford protection substantially equivalent to that of the wall of the cabinet or cutout box. Where metal plugs or plates are used with nonmetallic cabinets or cutout boxes, they shall be recessed at least 1/4 inch (6.35 mm) from the outer surface.

**373-5. Conductors Entering Cabinets or Cutout Boxes.** Conductors entering cabinets or cutout boxes shall be protected from abrasion and shall comply with (a) through (c) below.

**(a) Openings to Be Closed.** Openings through which conductors enter shall be adequately closed.

**(b) Metal Cabinets and Cutout Boxes.** Where metal cabinets or cutout boxes are installed with open wiring or concealed knob-and-tube wiring, conductors shall enter through insulating bushings or, in dry locations, through flexible tubing extending from the last insulating support and firmly secured to the cabinet or cutout box.

**(c) Cables.** Where cable is used, each cable shall be secured to the cabinet or cutout box.

**373-6. Deflection of Conductors.** Conductors at terminals or conductors entering or leaving cabinets or cutout boxes and the like shall comply with (b) through (c) below.

**(b) Wire Bending Space at Terminals.** Wire bending space at each terminal shall be provided in accordance with (1) or (2) below:

**Table 373-6(a). Minimum Wire Bending Space at Terminals and Minimum Width of Wiring Gutters in Inches**

| AWG or Circular-Mil Size of Wire | Wires per Terminal 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| 14-10 | Not Specified | — | — | — | — |
| 8-6 | 1½ | — | — | — | — |
| 4-3 | 2 | — | — | — | — |
| 2 | 2½ | — | — | — | — |
| 1 | 3 | — | — | — | — |

For SI units: one inch = 25.4 millimeters.

Bending space at terminals shall be measured in a straight line from the end of the lug or wire connector (in the direction that the wire leaves the terminal) to the wall, barrier, or obstruction.

**(1)** Table 373-6(a) shall apply where the conductor does not enter or leave the enclosure through the wall opposite its terminal.

*Exception No. 1: A conductor shall be permitted to enter or leave an enclosure through the wall opposite its terminal provided the conductor enters or leaves the enclosure where the gutter joins an adjacent gutter that has a width that conforms to Table 373-6(b) for that conductor.*

*Exception No. 2: A conductor not larger than 350 kcmil shall be permitted to enter or leave an enclosure containing only a meter socket(s) through the wall opposite its terminal provided the terminal is a lay-in type where either:*

*a. the terminal is directly facing the enclosure wall and offset is not greater than 50 percent of the bending space specified in Table 373-6(a), or*

*b. the terminal is directed toward the opening in the enclosure and is within a 45-degree angle of directly facing the enclosure wall.*

(FPN): Offset is the distance measured along the enclosure wall from the axis of the centerline of the terminal to a line passing through the center of the opening in the enclosure.

**(2)** Table 373-6(b) shall apply where the conductor enters or leaves the enclosure through the wall opposite its terminal.

**(c) Insulated Fittings.** Where ungrounded conductors of No. 4 or larger enter a raceway in a cabinet, pull box, junction box, or auxiliary gutter, the conductors shall be protected by a substantial fitting providing a smoothly rounded insulating surface, unless the conductors are separated from the raceway fitting by substantial insulating material securely fastened in place.

*Exception: Where threaded hubs or bosses that are an integral part of an enclosure provide a smoothly rounded or flared entry for conductors.*

Conduit bushings constructed wholly of insulating material shall not be used to secure a raceway. The insulating fitting or insulating material shall have a temperature rating not less than the insulation temperature rating of the installed conductors.

**Table 373-6(b). Minimum Wire Bending Space at Terminals for Section 373-6(b)(2) in Inches**

| Wire Size AWG | Wires per Terminal 1 | 2 | 3 | 4 or More |
|---|---|---|---|---|
| 14-10 | Not Specified | — | — | — |
| 8 | 1½ | — | — | — |
| 6 | 2 | — | — | — |
| 4 | 3 | — | — | — |
| 3 | 3 | — | — | — |
| 2 | 3½ | — | — | — |
| 1 | 4½ | — | — | — |
| 1/0 | 5½ | 5½ | 7 | — |
| 2/0 | 6 | 6 | 7½ | — |
| 3/0 | 6½ (½) | 6½ (½) | 8 | |
| 4/0 | 7 (1) | 7½ (1½) | 8½ (½) | — |

For SI units: one inch = 25.4 millimeters.

Bending space at terminals shall be measured in a straight line from the end of the lug or wire connector in a direction perpendicular to the enclosure wall.

For removable and lay-in wire terminals intended for only one wire, bending space shall be permitted to be reduced by the number of inches shown in parentheses.

**373-7. Space in Enclosures.** Cabinets and cutout boxes shall have sufficient space to accommodate all conductors installed in them without crowding.

**373-8. Enclosures for Switches or Overcurrent Devices.** Enclosures for switches or overcurrent devices shall not be used as junction boxes, auxiliary gutters, or raceways for conductors feeding through or tapping off to other switches or overcurrent devices.

*Exception: Where adequate space is provided so that the conductors do not fill the wiring space at any cross section to more than 40 percent of the cross-sectional area of the space, and so that the conductors, splices, and taps do not fill the wiring space at any cross section to more than 75 percent of the cross-sectional area of the space.*

## ARTICLE 380 — SWITCHES

### A. Installation

**380-1. Scope.** The provisions of this article shall apply to all switches, switching devices, and circuit breakers where used as switches.

**380-2. Switch Connections.**

**(a) Three-Way and Four-Way Switches.** Three-way and four-way switches shall be so wired that all switching is done only in the ungrounded circuit conductor. Where in metal raceways or metal-jacketed cables, wiring between switches and outlets shall be in accordance with Section 300-20(a).

*Exception: Switch loops shall not require a grounded conductor.*

**(b) Grounded Conductors.** Switches or circuit breakers shall not disconnect the grounded conductor of a circuit.

*Exception No. 1: Where the switch or circuit breaker simultaneously disconnects all conductors of the circuit.*

*Exception No. 2: Where the switch or circuit breaker is so arranged that the grounded conductor cannot be disconnected until all the ungrounded conductors of the circuit have been disconnected.*

**380-3. Enclosure.** Switches and circuit breakers shall be of the externally operable type mounted in an enclosure listed for the intended use. The minimum wire bending space at terminals and minimum gutter space provided in switch enclosures shall be as required in Section 373-6.

*Exception: Pendant- and surface-type snap switches and knife switches mounted on an open-face switchboard or panelboard.*

**380-4. Wet Locations.** A switch or circuit breaker in a wet location or outside of a building shall be enclosed in a weatherproof enclosure or cabinet that shall comply with Section 373-2(a).

**380-5. Time Switches, Flashers, and Similar Devices.** Time switches, flashers, and similar devices shall be of the enclosed type or shall be mounted in cabinets or boxes or equipment enclosures. Energized parts shall be barriered to prevent operator exposure when making manual adjustments or switching.

*Exception: Where mounted so they are accessible only to qualified persons and so located in an enclosure that any energized parts within 6 inches (152 mm) of the manual adjustment or switch are covered by suitable barriers.*

**380-8. Accessibility and Grouping.**

**(a) Location.** All switches and circuit breakers used as switches shall be so located that they may be operated from a readily accessible place. They shall be so installed that the center of the grip of the operating handle of the switch or circuit breaker, when in its highest position, will not be more than 6½ feet (1.98 m) above the floor or working platform.

*Exception No. 2: Switches installed adjacent to motors, appliances, or other equipment which they supply shall be permitted to be located higher than specified in the foregoing and to be accessible by portable means.*

**380-9. Faceplates for Flush-Mounted Snap Switches.** Flush snap switches, that are mounted in ungrounded metal boxes and located within reach of conducting floors or other conducting surfaces, shall be provided with faceplates of nonconducting, noncombustible material. Metal faceplates shall be of ferrous metal not less than 0.030 inch (0.762 mm) in thickness or of nonferrous metal not less than 0.040 inch (1.016 mm) in thickness. Faceplates of insulating material shall be noncombustible and not less than 0.10 inch (2.54 mm) in thickness but they shall be permitted to be less than 0.10 inch (2.54 mm) in thickness if formed or reinforced to provide adequate mechanical strength. Faceplates shall be installed so as to completely cover the wall opening and seat against the wall surface.

**380-10. Mounting of Snap Switches.**

**(b) Box Mounted.** Flush-type snap switches mounted in boxes that are set back of the wall surface as permitted in Section 370-10 shall be installed so that the extension plaster ears are seated against the surface of the wall. Flush-type snap switches mounted in boxes that are flush with the wall surface or project therefrom shall be so installed that the mounting yoke or strap of the switch is seated against the box.

**380-11. Circuit Breakers as Switches.** A hand-operable circuit breaker equipped with a lever or handle, or a power-operated circuit breaker capable of being opened by hand in the event of a power failure, shall be permitted to serve as a switch if it has the required number of poles. Note: See provisions contained in Section 240-81 in the NEC.

**380-12. Grounding of Enclosures.** Metal enclosures for switches or circuit breakers shall be grounded as specified in Article 250. Where nonmetallic enclosures are used with metal-sheathed cables or metallic conduits, provision shall be made for grounding continuity.

**380-14. Rating and Use of Snap Switches.** Snap switches shall be used within their ratings and as indicated in (a) through (c) below:

**(a) AC General-Use Snap Switch.** A form of general-use snap switch suitable only for use on alternating-current circuits for controlling the following:

**(1)** Resistive and inductive loads, including electric-discharge lamps, not exceeding the ampere rating of the switch at the voltage involved.

**(2)** Tungsten-filament lamp loads not exceeding the ampere rating of the switch at 120 volts.

**(3)** Motor loads not exceeding 80 percent of the ampere rating of the switch at its rated voltage.

**(b) AC-DC General-Use Snap Switch.** A form of general-use snap switch suitable for use on either ac or dc circuits for controlling the following:

**(1)** Resistive loads not exceeding the ampere rating of the switch at the voltage applied.

**(2)** Inductive loads not exceeding 50 percent of the ampere rating of the switch at the applied voltage. Switches rated in horsepower are suitable for controlling motor loads within their rating at voltage applied.

**(3)** Tungsten-filament lamp loads not exceeding the ampere rating of the switch at the applied voltage if "T" rated.

(FPN): For switches controlling motors, see Sections 430-83, 430-109, and 430-110 in the NEC.

**(c) CO/ALR Snap Switches.** Snap switches rated 20 amperes or less directly connected to aluminum conductors shall be listed and marked CO/ALR.

## ARTICLE 384 — PANELBOARDS

**384-1. Scope.** This article covers panelboards and distribution boards installed for the control of light and power circuits.

**384-2. Other Articles.** Switches, circuit breakers, and overcurrent devices used on switchboards, panelboards, and distribution boards, and their enclosures, shall comply with this article and also with the requirements of Articles 240, 250, 370, 373, 380, and other articles that apply.

**384-3. Support and Arrangement of Busbars and Conductors.**

**(c) Used As Service Equipment** Each panelboard, if used as service equipment, shall be provided with a main bonding jumper sized in accordance with Section 250-79(d) or the equivalent placed within the panelboard for connecting the grounded service conductor on its supply side to the panelboard frame.

**384-13. General.** All panelboards shall have a rating not less than the minimum feeder capacity required for the load computed in accordance with Article 220. Panelboards shall be durably marked by the manufacturer with the voltage and the current rating and the number of phases for which they are designed and with the manufacturer's name or trademark in such a manner as to be visible after installation, without disturbing the interior parts or wiring. All panelboard circuits and circuit modifications shall be legibly identified as to purpose or use on a circuit directory located on the face or inside of the panel doors.

(FPN): See Section 110-22 for additional requirements.

**384-14. Lighting and Appliance Branch-Circuit Panelboard.** For the purposes of this article, a lighting and appliance branch-circuit panelboard is one having more than 10 percent of its overcurrent devices rated 30 amperes or less, for which neutral connections are provided.

**384-15. Number of Overcurrent Devices on One Panelboard.** Not more than forty-two overcurrent devices (other than those provided for in the mains) of a lighting and appliance branch-circuit panelboard shall be installed in any one cabinet or cutout box.

A lighting and appliance branch-circuit panelboard shall be provided with physical means to prevent the installation of more overcurrent devices than that number for which the panelboard was designed, rated, and approved.

For the purposes of this article, a 2-pole circuit breaker shall be considered two overcurrent devices; a 3-pole breaker shall be considered three overcurrent devices.

**384-16. Overcurrent Protection.**

**(a) Lighting and Appliance Branch-Circuit Panelboard Individually Protected.** Each lighting and appliance branch-circuit panelboard shall be individually protected on the supply side by not more than two main circuit breakers or two sets of fuses having a combined rating not greater than that of the panelboard.

*Exception No. 1: Individual protection for a lighting and appliance panelboard shall not be required if the panelboard feeder has overcurrent protection not greater than the rating of the panelboard.*

*Exception No. 2: For existing installations, individual protection for lighting and appliance branch-circuit panelboards shall not be required where such panelboards are used as service equipment in supplying an individual residential occupancy.*

**(b) Snap Switches Rated at 30 Amperes or Less.** Panelboards equipped with snap switches rated at 30 amperes or less shall have overcurrent protection not in excess of 200 amperes.

**(c) Continuous Load.** The total load on any overcurrent device located in a panelboard shall not exceed 80 percent of its rating where in normal operation the load will continue for 3 hours or more.

*Exception: Where the assembly including the overcurrent device is approved for continuous duty at 100 percent of its rating.*

**384-17. Panelboards in Damp or Wet Locations.** Panelboards in damp or wet locations shall be installed to comply with Section 373-2(a).

**384-18. Enclosure.** Panelboards shall be mounted in cabinets, cutout boxes, or enclosures designed for the purpose and shall be dead front.

*Exception: Panelboards other than of the dead front externally operable type shall be permitted where accessible only to qualified persons.*

**384-19. Relative Arrangement of Switches and Fuses.** In panelboards, fuses of any type shall be installed on the load side of any switches.

*Exception: As provided in Section 230-94 for use as service equipment.*

**384-20. Grounding of Panelboards.** Panelboard cabinets and panelboard frames, if of metal, shall be in physical contact with each other and shall be grounded in accordance with Article 250 or Section 384-3(c). Where the panelboard is used with nonmetallic raceway or cable, or where separate grounding conductors are provided a terminal bar for the grounding conductors shall be secured inside the cabinet. The terminal bar shall be bonded to the cabinet and panelboard frame, if of metal, otherwise it shall be connected to the grounding conductor that is run with the conductors feeding the panelboard.

Grounding conductors shall not be connected to a terminal bar provided for grounded conductors (may be a neutral) unless the bar is identified for the purpose and is located where connection is made from the grounded conductor to a grounding electrode as permitted or required by Article 250.

## ARTICLE 400 — FLEXIBLE CORDS AND CABLES

### A. General

**400-1. Scope.** This article covers general requirements, applications, and construction specifications for flexible cords and flexible cables.

**400-2. Other Articles.** Flexible cords and flexible cables shall comply with this article and with the applicable provisions of other articles of this Code.

**400-3. Suitability.** Flexible cords and cables and their associated fittings shall be suitable for the conditions of use and location.

**400-7. Uses Permitted.**

**(a) Uses.** Flexible cords and cables shall be used only for (1) pendants; (2) wiring of fixtures; (3) connection of portable lamps or appliances; (6) connection of stationary equipment to facilitate their frequent interchange; (7) prevention of the transmission of noise or vibration; (8) appliances where the fastening means and mechanical connections are specifically designed to permit ready removal for maintenance and repair, and the appliance is intended or identified for flexible cord connection; (10) connection of moving parts; or (11) temporary wiring as permitted in Sections 305-4(b) and 305-4(c).

**(b) Attachment Plugs.** Where used as permitted in subsections (a)(3), (a)(6), and (a)(8) of this section, each flexible cord shall be equipped with an attachment plug and shall be energized from a receptacle outlet.

**400-8. Uses Not Permitted.** Unless specifically permitted in Section 400-7 flexible cords and cables shall not be used (1) as a substitute for the fixed wiring of a structure; (2) where run through holes in walls, ceilings, or floors; (3) where run through doorways, windows, or similar openings; (4) where attached to building surfaces; (5) where concealed behind building walls, ceilings, or floors; or (6) where installed in raceways, except as otherwise permitted in this Code.

*Exception: Flexible cord and cable shall be permitted to have one connection to the building surface for a suitable tension take-up device. Travel from the cord or cable termination to the tension take-up device shall be limited to six feet (1.83 m).*

**400-9. Splices.** Flexible cord shall be used only in continuous lengths without splice or tap when initially installed in applications permitted by Section 400-7(a). The repair of hard service cord (see Column 1, Table 400-4 in the NEC) No. 14 and larger shall be permitted if conductors are spliced in accordance with Section 110-14(b) and the completed splice retains the insulation, outer sheath properties, and usage characteristics of the cord being spliced.

## ARTICLE 410 — LIGHTING FIXTURES, LAMPHOLDERS, LAMPS, AND RECEPTACLES

### A. General

**410-1. Scope.** This article covers lighting fixtures, lampholders, pendants, receptacles, incandescent filament lamps, arc lamps, electric-discharge lamps, the wiring and equipment forming part of such lamps, fixtures and lighting installations.

**410-3. Live Parts.** Fixtures, lampholders, lamps, and receptacles shall have no live parts normally exposed to contact. Exposed accessible terminals in lampholders, receptacles, and switches shall not be installed in metal fixture canopies or in open bases of portable table or floor lamps.

*Exception: Cleat-type lampholders and receptacles located at least 8 feet (2.44 m) above the floor shall be permitted to have exposed contacts.*

### B. Fixture Locations

**410-4. Fixtures in Specific Locations.**

**(a) Wet and Damp Locations.** Fixtures installed in wet or damp locations shall be so installed that water cannot enter or accumulate in wiring compartments, lampholders, or other electrical parts. All fixtures installed in wet locations shall be marked, "Suitable for Wet Locations." All fixtures installed in damp locations shall be marked, "Suitable for Wet Locations" or "Suitable for Damp Locations."

Installations underground or in concrete slabs or masonry in direct contact with the earth, and locations subject to saturation with water or other liquids, such as locations exposed to weather and unprotected, vehicle washing areas, and like locations, shall be considered to be wet locations with respect to the above requirement.

Interior locations protected from weather but subject to moderate degrees of moisture, such as some basements, some barns, some cold-storage warehouses and the like, the partially protected locations under canopies, marquees, roofed open porches, and the like, shall be considered to be damp locations with respect to the above requirement.

(FPN): See Article 680 for lighting fixtures in swimming pools.

**(b) Corrosive Locations.** Fixtures installed in corrosive locations shall be of a type suitable for such locations.

(FPN): See Section 210-7 for receptacles in fixtures.

**(d) Pendants.** No parts of cord-connected fixtures, hanging fixtures, or pendants shall be located within a zone measured 3 feet (914 mm) horizontally and 8 feet (2.44 m) vertically from the top of the bathtub rim. This zone is all encompassing and includes the zone directly over the tub.

**410-5. Fixtures Near Combustible Material.** Fixtures shall be so constructed, or installed, or equipped with shades or guards that combustible material will not be subjected to temperatures in excess of 90°C (194°F).

**410-6. Fixtures Over Combustible Material.** Lampholders installed over highly combustible material shall be of the unswitched type. Unless an individual switch is provided for each fixture, lampholders shall be located at least 8 feet (2.44 m) above the floor, or shall be so located or guarded that the lamps cannot be readily removed or damaged.

## 410-8. Fixtures in Clothes Closets.

**(a) Definition.**

**Storage Space:** Storage space shall be defined as a volume bounded by the sides and back closet walls and planes extending from the closet floor vertically to a height of 6 feet (1.83 m) or the highest clothes-hanging rod and parallel to the walls at a horizontal distance of 24 inches (610 mm) from the sides and back of the closet walls respectively, and continuing vertically to the closet ceiling parallel to the walls at a horizontal distance of 12 inches (305 mm) or the width of the shelf, whichever is greater.

(FPN): See Figure 410-8.

For a closet that permits access to both sides of a hanging rod, the storage space shall include the volume below the highest rod extending 12 inches (305 mm) on either side of the rod on a plane horizontal to the floor extending the entire length of the rod.

**(b) Fixture Types Permitted.** Listed fixtures of the following types shall be permitted to be installed in a closet:

**(1)** A surface-mounted or recessed incandescent fixture with a completely enclosed lamp.

**(2)** A surface-mounted or recessed fluorescent fixture.

**(c) Fixture Types Not Permitted.** Incandescent fixtures with open or partially enclosed lamps and pendant fixtures or lampholders shall not be permitted.

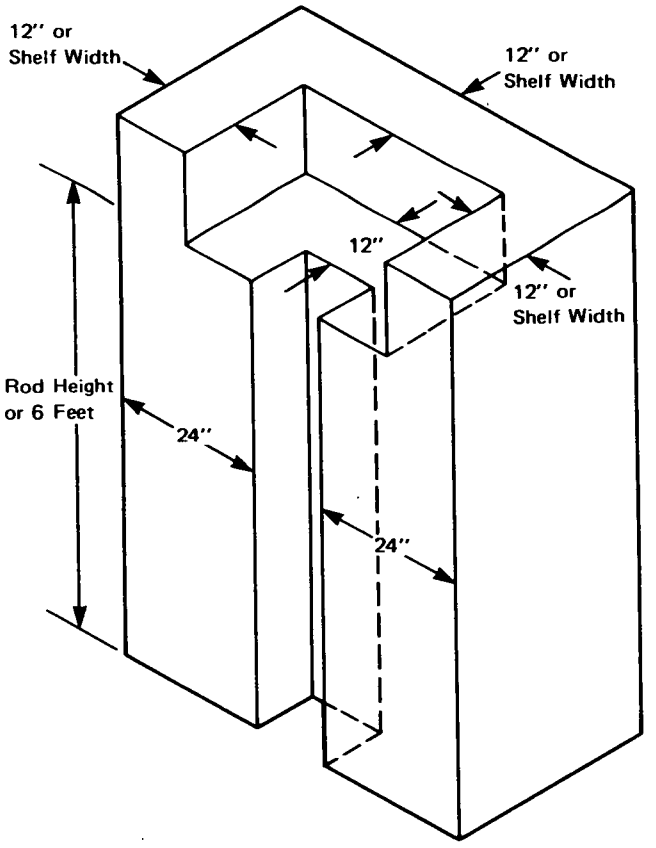
**(d) Location.** Fixtures in clothes closets shall be permitted to be installed as follows:

**(1)** Surface-mounted incandescent fixtures installed on the wall above the door or on the ceiling provided there is a minimum clearance of 12 inches (305 mm) between the fixture and the nearest point of a storage area.

**(2)** Surface-mounted fluorescent fixtures installed on the wall above the door or on the ceiling providing there is a minimum clearance of 6 inches (152 mm) between the fixture and the nearest point of a storage area.

**(3)** Recessed incandescent fixtures with a completely enclosed lamp installed in the wall or the ceiling providing there is a minimum clearance of 6 inches (152 mm) between the fixture and the nearest point of a storage area.

**(4)** Recessed fluorescent fixtures installed in the wall or on the ceiling providing there is a minimum clearance of 6 inches (152 mm) between the fixture and the nearest point of a storage area.




For SI Units: One inch = 25.4 millimeters; one foot = 0.3048 meter.

**(FPN): Closet storage space - Figure 410-8.**

**410-9. Space for Cove Lighting.** Coves shall have adequate space and shall be so located that lamps and equipment can be properly installed and maintained.

### C. Provisions at Fixture Outlet Boxes, Canopies, and Pans

**410-10. Space for Conductors.** Canopies and outlet boxes taken together shall provide adequate space so that fixture conductors and their connecting devices can be properly installed.

**410-11. Temperature Limit of Conductors in Outlet Boxes.** Fixtures shall be of such construction or so installed that the conductors in outlet boxes shall not be subjected to temperatures greater than that for which the conductors are rated.

Branch-circuit wiring shall not be passed through an outlet box that is an integral part of an incandescent fixture unless the fixture is identified for through wiring.

**410-12. Outlet Boxes to Be Covered.** In a completed installation, each outlet box shall be provided with a cover unless covered by means of a fixture canopy, lampholder, receptacle, rosette, or similar device.

**410-13. Covering of Combustible Material at Outlet Boxes.** Any combustible wall or ceiling finish exposed between the edge of a fixture canopy or pan and an outlet box shall be covered with noncombustible material.

**410-14. Connection of Electric-Discharge Lighting Fixtures.**

**(a) Independently of the Outlet Box.** Where electric-discharge lighting fixtures are supported independently of the outlet box, they shall be connected through metal raceways, nonmetallic raceways, Type MC cable, Type AC cable, Type MI cable, or nonmetallic-sheathed cables.

*Exception: Cord-connected fixtures shall be permitted as provided in Sections 410-30(b) and (c).*

**(b) Access to Boxes.** Electric discharge lighting fixtures surface mounted over concealed outlet, pull, or junction boxes shall be installed with suitable openings in back of the fixture to provide access to the boxes.

## D. Fixture Supports

**410-15. Supports.**

**(a) General.** Fixtures, lampholders, rosettes, and receptacles shall be securely supported. A fixture that weighs more than 6 pounds (2.72 kg) or exceeds 16 inches (406 mm) in any dimension shall not be supported by the screw shell of a lampholder.

**410-16. Means of Support.**

**(a) Outlet Boxes.** Where the outlet box or fitting will provide adequate support, a fixture shall be attached thereto or be supported as required by Section 370-13 for boxes. A fixture that weighs more than 50 pounds (22.7 kg) shall be supported independently of the outlet box.

**(b) Inspection.** Fixtures shall be so installed that the connections between the fixture conductors and the circuit conductors can be inspected without requiring the disconnection of any part of the wiring.

*Exception: Fixtures connected by attachment plugs and receptacles.*

**(c) Suspended Ceilings.** Framing members of suspended ceiling systems used to support fixtures shall be securely fastened to each other and shall be securely attached to the building structure at appropriate intervals.

Fixtures shall be securely fastened to the ceiling framing member by mechanical means, such as bolts, screws, or rivets. Clips identified for use with the type of ceiling framing member(s) and fixture(s) shall also be permitted.

**(d) Fixture Studs.** Fixture studs that are not a part of outlet boxes, hickeys, tripods, and crowfeet shall be made of steel, malleable iron, or other material suitable for the application.

**(e) Insulating Joints.** Insulating joints that are not designed to be mounted with screws or bolts shall have an exterior metal casing, insulated from both screw connections.

**(f) Raceway Fittings.** Raceway fittings used to support lighting fixture(s) shall be capable of supporting the weight of the complete fixture assembly and lamp(s).

**(h) Trees.** Outdoor lighting fixtures and associated equipment shall be permitted to be supported by trees.

(FPN): See Section 225-26 in the NEC.

## E. Grounding

**410-17. General.** Fixtures and lighting equipment shall be grounded as provided in Part E of this article.

**410-18. Exposed Fixture Parts.**

**(a) With Exposed Conductive Parts.** The exposed conductive parts of lighting fixtures and equipment directly wired or attached to outlets supplied by a wiring method which provides an equipment ground shall be grounded.

**(b) Made of Insulating Material.** Fixtures directly wired or attached to outlets supplied by a wiring method which does not provide a ready means for grounding shall be made of insulating material and shall have no exposed conductive parts.

**410-20. Equipment Grounding Conductor Attachment.** Fixtures with exposed metal parts shall be provided with a means for connecting an equipment grounding conductor for such fixtures.

**410-21. Methods of Grounding.** Fixtures and equipment shall be considered grounded where mechanically connected to an equipment grounding conductor as specified in Section 250-91(b) and sized in accordance with Section 250-95.

## F. Wiring of Fixtures

**410-22. Fixture Wiring — General.** Wiring on or within fixtures shall be neatly arranged and shall not be exposed to physical damage. Excess wiring shall be avoided. Conductors shall be so arranged that they shall not be subjected to temperatures above those for which they are rated.

**410-23. Polarization of Fixtures.** Fixtures shall be so wired that the screw shells of lampholders will be connected to the same fixture or circuit conductor or terminal. The grounded conductor, where connected to a screw-shell lampholder, shall be connected to the screw shell.

**410-28. Protection of Conductors and Insulation.**

**(a) Properly Secured.** Conductors shall be secured in a manner that will not tend to cut or abrade the insulation.

**(b) Protection Through Metal.** Conductor insulation shall be protected from abrasion where it passes through metal.

**(c) Fixture Stems.** Splices and taps shall not be located within fixture arms or stems.

**(d) Splices and Taps.** No unnecessary splices or taps shall be made within or on a fixture.

(FPN): For approved means of making connections, see Section 110-14.

**(e) Stranding.** Stranded conductors shall be used for wiring on fixture chains and on other movable or flexible parts.

**(f) Tension.** Conductors shall be so arranged that the weight of the fixture or movable parts will not put a tension on the conductors.

**410-30. Cord-Connected Lampholders and Fixtures.**

**(c) Electric-Discharge Fixtures.** It shall be permissible to locate cord-equipped fixtures directly below the outlet box, if the cord is continuously visible for its entire length outside the fixture and is not subject to strain or physical damage. Such cord-equipped fixtures shall terminate at the outer end of the cord in a grounding-type attachment plug (cap) or busway plug.

**410-31. Fixtures as Raceways.** Fixtures shall not be used as a raceway for circuit conductors.

*Exception No. 1: Fixtures listed for use as a raceway.*

*Exception No. 2: Fixtures designed for end-to-end assembly to form a continuous raceway or fixtures connected together by recognized wiring methods shall be permitted to carry through conductors of a two-wire or multiwire branch circuit supplying the fixtures.*

*Exception No. 3: One additional two-wire branch circuit separately supplying one or more of the connected fixtures described in Exception No. 2 shall be permitted to be carried through the fixtures.*

(FPN): See Article 100 for definition of multiwire branch circuit.

Branch circuit conductors within 3 inches (76 mm) of a ballast within the ballast compartment shall have an insulation temperature rating not lower than 90°C (194°F), such as Types RHH, THW, THHN, THHW, FEP, FEPB, SA, and XHHW.

## H. Installation of Lampholders

**410-47. Screw-Shell Type.** Lampholders of the screw-shell type shall be installed for use as lampholders only. Where supplied by a circuit having a grounded conductor, the grounded conductor shall be connected to the screw shell.

**410-48. Double-Pole Switched Lampholders.** Where supplied by the ungrounded conductors of a circuit, the switching device of lampholders of the switched type shall simultaneously disconnect both conductors of the circuit.

**410-49. Lampholders in Wet or Damp Locations.** Lampholders installed in wet or damp locations shall be of the weatherproof type.

## L. Receptacles, Cord Connectors, and Attachment Plugs (Caps)

### 410-56. Rating and Type.

**(a) Receptacles.** Receptacles installed for the attachment of portable cords shall be rated at not less than 15 amperes, 125 volts, or 15 amperes, 250 volts, and shall be of a type not suitable for use as lampholders.

**(b) CO/ALR Receptacles.** Receptacles rated 20 amperes or less and directly connected to aluminum conductors shall be marked CO/ALR.

**(d) Faceplates.** Metal faceplates shall be of ferrous metal not less than 0.030 inch (762 micrometers) in thickness or of nonferrous metal not less than 0.040 inch (1 mm) in thickness. Metal faceplates shall be grounded. Faceplates of insulating material shall be noncombustible and not less than 0.10 inch (2.54 mm) in thickness but shall be permitted to be less than 0.10 inch (2.54 mm) in thickness if formed or reinforced to provide adequate mechanical strength.

**(e) Position of Receptacle Faces.** After installation, receptacle faces shall be flush with or project from faceplates of insulating material and shall project a minimum of 0.015 inch (381 micrometers) from metal faceplates. Faceplates shall be installed so as to completely cover the opening and seat against the mounting surface. Receptacles mounted in boxes that are set back of the wall surface, as permitted in Section 370-10, shall be installed so that the mounting yoke or strap of the receptacle is held rigidly at the surface of the wall. Receptacles mounted in boxes that are flush with the wall surface or project therefrom shall be so installed that the mounting yoke or strap of the receptacle is seated against the box or raised box cover.

### 410-57. Receptacles in Damp or Wet Locations.

**(a) Damp Locations.** A receptacle installed outdoors in a location protected from the weather or in other damp locations shall have an enclosure for the receptacle that is weatherproof when the receptacle is covered (attachment plug cap not inserted and receptacle covers closed).

An installation suitable for wet locations shall also be considered suitable for damp locations.

A receptacle shall be considered to be in a location protected from the weather where located under roofed open porches, canopies, marquees, and the like, and will not be subjected to a beating rain or water run-off.

**(b) Wet Locations.** A receptacle installed outdoors where exposed to weather or in other wet locations shall be in a weatherproof enclosure, the integrity of which is not affected when the receptacle is in use (attachment plug cap inserted).

*Exception: An enclosure that is weatherproof only when a self-closing receptacle cover is closed shall be permitted to be used for a receptacle installed outdoors where the receptacle is not to be used with other than portable tools or other portable equipment not left connected to the outlet indefinitely.*

**(d) Flush Mounting with Faceplate.** The enclosure for a receptacle installed in an outlet box flush-mounted on a wall surface shall be made weatherproof by means of a weatherproof faceplate assembly that provides a watertight connection between the plate and the wall surface.

**(e) Installation.** A receptacle outlet installed outdoors shall be located so that water accumulation is not likely to touch the outlet cover or plate.

### 410-58. Grounding-type Receptacles, Adapters, Cord Connectors, and Attachment Plugs.

**(c) Grounding Terminal Use.** A grounding terminal or grounding-type device shall not be used for purposes other than grounding.

## M. Special Provisions for Flush and Recessed Fixtures

**410-64. General.** Fixtures installed in recessed cavities in walls or ceilings shall comply with Sections 410-65 through 410-72.

### 410-65. Temperature.

**(a) Combustible Material.** Fixtures shall be so installed that adjacent combustible material will not be subjected to temperatures in excess of 90°C (194°F).

**(b) Fire-Resistant Construction.** Where a fixture is recessed in fire-resistant material in a building of fire-resistant construction, a temperature higher than 90°C (194°F), but not higher than 150°C (302°F), shall be considered acceptable if the fixture is plainly marked that it is listed for that service.

**(c) Recessed Incandescent Fixtures.** Incandescent fixtures shall have thermal protection and shall so be identified as thermally protected.

*Exception No. 1: Recessed incandescent fixtures identified for use and installed in poured concrete.*

*Exception No. 2: Listed recessed incandescent fixtures that provide, by construction design, the equivalent temperature performance characteristics of thermally protected fixtures and are so identified.*

### 410-66. Clearance and Installation.

**(a) Clearance.** Recessed portions of lighting fixture enclosures, other than at the points of support, shall be spaced at least ½ inch (12.7 mm) from combustible materials.

*Exception: Recessed fixtures identified as suitable for insulation to be in direct contact with the fixture.*

**(b) Installation.** Thermal insulation shall not be installed within 3 inches (76 mm) of the recessed fixture enclosure, wiring compartment, or ballast, and shall not be so installed above the fixture so as to entrap heat and prevent the free circulation of air.

*Exception: Recessed fixtures identified as suitable for insulation to be in direct contact with the fixture.*

### 410-67. Wiring.

**(a) General.** Conductors having insulation suitable for the temperature encountered shall be used.

**(b) Circuit Conductors.** Branch-circuit conductors having an insulation suitable for the temperature encountered shall be permitted to terminate in the fixture.

**(c) Tap Conductors.** Tap conductors of a type suitable for the temperature encountered shall be permitted to run from the fixture terminal connection to an outlet box placed at least 1 foot (305 mm) from the fixture. Such tap conductors shall be in suitable raceway or Types AC or MC cable of at least 4 feet (1.22 m) but not more than 6 feet (1.83 m) in length.

## P. Special Provisions for Electric-Discharge Lighting Systems of 1000 Volts or Less

### 410-73. General.

**(a) Open-Circuit Voltage of 1000 Volts or Less.** Equipment for use with electric-discharge lighting systems and designed for an open-circuit voltage of 1000 volts or less shall be of a type intended for such service.

**(e) Thermal Protection.** Where fluorescent fixtures are installed indoors, the ballasts shall have thermal protection integral within the ballast. Replacement ballasts for all fluorescent fixtures installed indoors shall also have thermal protection integral within the ballast.

*Exception to (e) above: Fluorescent fixtures with simple reactance ballasts.*

**(f) Recessed High-Intensity Discharge Fixtures.** Recessed high-intensity discharge fixtures shall be thermally protected and shall be so identified. Where fixtures are operated by remote ballasts, the ballasts shall also be thermally protected.

**410-75. Open-Circuit Voltage Exceeding 300 Volts.** Equipment having an open-circuit voltage exceeding 300 volts shall not be installed in dwelling occupancies unless such equipment is so designed that there will be no exposed live parts when lamps are being inserted, are in place, or are being removed.

### 410-76. Fixture Mounting.

**(a) Exposed Ballasts.** Fixtures having exposed ballasts or transformers shall be so installed that such ballasts or transformers will not be in contact with combustible material.

**(b) Combustible Low-Density Cellulose Fiberboard.** Where a surface-mounted fixture containing a ballast is to be installed on combustible low-density cellulose fiberboard, it shall be listed for this condition or shall be spaced not less than $1\frac{1}{2}$ inches (38 mm) from the surface of the fiberboard. Where such fixtures are partially or wholly recessed, the provisions of Sections 410-64 through 410-72 shall apply.

(FPN): Combustible low-density cellulose fiberboard includes sheets, panels, and tiles that have a density of 20 pounds per cubic foot (320.36 kg/cu m) or less, and that are formed of bonded plant fiber material but does not include solid or laminated wood, nor fiberboard that has a density in excess of 20 pounds per cubic foot (320.36 kg/cu m) or is a material that has been integrally treated with fire-retarding chemicals to the degree that the flame spread in any plane of the material will not exceed 25, determined in accordance with tests for surface burning characteristics of building materials. See Test Method for Surface Burning Characteristics of Building Materials, ANSI/ASTM E84-1984.

## Q. Special Provisions for Electric-Discharge Lighting Systems of More than 1000 Volts

### 410-80. General.

**(b) Dwelling Occupancies.** Equipment having an open-circuit voltage exceeding 1000 volts shall not be installed in dwelling occupancies.

## R. Lighting Track

**410-100. Definition.** Lighting track is a manufactured assembly designed to support and energize lighting fixtures which are capable of being readily repositioned on the track. Its length may be altered by the addition or subtraction of sections of track.

### 410-101. Installation.

**(a) Lighting Track.** Lighting track shall be permanently installed and permanently connected to a branch circuit. Only lighting track fittings shall be installed on lighting track. Lighting track fittings shall not be equipped with general-purpose receptacles.

**(b) Connected Load.** The connected load on lighting track shall not exceed the rating of the track. Lighting track shall be supplied by a branch circuit having a rating not more than that of the track.

**(d) Support.** Fittings identified for use on lighting track shall be designed specifically for the track on which they are to be installed. They shall be securely fastened to the track, maintain polarization and grounding, and shall be designed to be suspended directly from the track.

# ARTICLE 422 — APPLIANCES

## A. General

**422-1. Scope.** This article covers electric appliances used in any occupancy.

**422-2. Live Parts.** Appliances shall have no live parts normally exposed to contact.

*Exception: Toasters, grills, or other appliances in which the current-carrying parts at high temperatures are necessarily exposed.*

## B. Branch-Circuit Requirements

**422-4. Branch-Circuit Sizing.** This section specifies sizes of conductors capable of carrying appliance current without overheating under the conditions specified. This section shall not apply to conductors that form an integral part of an appliance.

**(a) Individual Circuits.** The rating of an individual branch circuit shall not be less than the marked rating of the appliance or the marked rating of an appliance having combined loads as provided in Section 422-32.

*Exception No. 1: For motor-operated appliances not having a marked rating the branch-circuit size shall be in accordance with Part B of Article 430 in the NEC.*

*Exception No. 2: For an appliance, other than a motor-operated appliance, that is continuously loaded, the branch-circuit rating shall not be less than 125 percent of the marked rating; or not less than 100 percent if the branch-circuit device and its assembly is listed for continuous loading at 100 percent of its rating.*

*Exception No. 3: Branch circuits for household cooking appliances shall be permitted to be in accordance with Table 220-19.*

**(b) Circuits Supplying Two or More Loads.** For branch circuits supplying appliance and other loads, the rating shall be determined in accordance with Section 210-23.

**422-5. Branch-Circuit Overcurrent Protection.** Branch circuits shall be protected in accordance with Section 240-3.

If a protective device rating is marked on an appliance, the branch-circuit overcurrent device rating shall not exceed the protective device rating marked on the appliance.

## C. Installation of Appliances

**422-6. General.** All appliances shall be installed in an approved manner.

**422-7. Central Heating Equipment.** Central heating equipment other than fixed electric space heating equipment shall be supplied by an individual branch circuit.

*Exception: Auxiliary equipment such as a pump, valve, humidifier, or electrostatic air cleaner directly associated with the heating equipment shall be permitted to be connected to the same branch circuit.*

**422-8. Flexible Cords.**

**(c) Other Appliances.** Flexible cord shall be permitted: (1) for connection of appliances to facilitate their frequent interchange or to prevent the transmission of noise or vibration, or (2) to facilitate the removal or disconnection of appliances that are fastened in place, where the fastening means and mechanical connections are specifically designed to permit ready removal for maintenance or repair, and the appliance is intended or identified for flexible cord connection.

**(d) Specific Appliances.**

**(1)** Electrically operated kitchen waste disposers intended for dwelling unit use and provided with a Type S, SE, SEO, SO, SOO, ST, STO, STOO, SJ, SJE, SJEO, SJO, SJT, SJTO, SJTOO, SP-3, SPE-3, or SPT-3, three-conductor cord terminated with a grounding-type attachment plug shall be permitted where all of the following conditions are met:

a. The length of the cord shall not be less than 18 inches (457 mm) and not over 36 inches (914 mm).

b. Receptacles shall be located to avoid physical damage to the flexible cord.

c. The receptacle shall be accessible.

**(2)** Built-in dishwashers and trash compactors intended for dwelling unit use and provided with a Type S, SE, SEO, SO, SOO, ST, STO, STOO, SJ, SJE, SJEO, SJO, SJT, SJTO, SJTOO, SP-3, SPE-3, or SPT-3, three-conductor cord terminated with a grounding-type attachment plug shall be permitted where all of the following conditions are met:

a. The length of the cord shall be 3 to 4 feet (0.914 to 1.22 m).

b. Receptacles shall be located to avoid physical damage to the flexible cord.

c. The receptacle shall be located in the space occupied by the appliance or adjacent thereto.

d. The receptacle shall be accessible.

*Exception: Listed kitchen waste disposers, dishwashers and trash compactors protected by a system of double insulation, or its equivalent, shall not be required to be grounded. Where such a system is employed, the equipment shall be distinctively marked.*

**422-10. Protection of Combustible Material.** Each electrically heated appliance that is intended by size, weight, and service to be located in a fixed position shall be so placed as to provide ample protection between the appliance and adjacent combustible material.

## 422-14. Water Heaters.

**(a) Storage- and Instantaneous-type Water Heaters.** Each storage- or instantaneous-type water heater shall be equipped with a temperature-limiting means in addition to its control thermostat to disconnect all ungrounded conductors, and such means shall be: (1) installed to sense maximum water temperature and, (2) either a trip-free, manually reset type or a type having a replacement element. Such water heaters shall be marked to require the installation of a temperature and pressure relief valve.

(FPN): See Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems, ANSI Z21.22-1986.

*Exception: Water heaters with supply water temperature of 82°C (180°F) or above and a capacity of 60 kW or above and identified as being suitable for this use; and water heaters with a capacity of 1 gallon (3.785 L) or less and identified as being suitable for such use.*

**(b) Storage-type Water Heaters.** A branch circuit supplying a fixed storage-type water heater having a capacity of 120 gallons (454.2 L) or less shall have a rating not less than 125 percent of the nameplate rating of the water heater.

(FPN): For branch-circuit sizing, see Section 422-4(a), Exception No. 2.

**422-16. Grounding.** Appliances required by Article 250 to be grounded shall have exposed noncurrent-carrying metal parts grounded in the manner specified in Article 250.

(FPN): See Sections 250-42, 250-43 and 250-45 for equipment grounding of refrigerators and freezers and Sections 250-57 and 250-60 for equipment grounding of electric ranges, wall-mounted ovens, counter-mounted cooking units, and clothes dryers.

## 422-17. Wall-Mounted Ovens and Counter-Mounted Cooking Units.

**(a) Permitted to Be Cord- and Plug-Connected or Permanently Connected.** Wall-mounted ovens and counter-mounted cooking units complete with provisions for mounting and for making electrical connections shall be permitted to be permanently connected or, only for ease in servicing or for installation, cord- and plug-connected.

**(b) Separable Connector or a Plug and Receptacle Combination.** A separable connector or a plug and receptacle combination in the supply line to an oven or cooking unit shall:

**(1)** Not be installed as the disconnecting means required by Section 422-20.

**(2)** Be approved for the temperature of the space in which it is located.

**422-18. Support of Ceiling Fans.** Listed ceiling fans that do not exceed 35 pounds (15.88 kg) in weight, with or without accessories, shall be permitted to be supported by outlet boxes identified for such use and supported in accordance with Sections 370-13 and 370-17.

**422-19. Other Installation Methods.** Appliances employing methods of installation other than covered by this article shall be permitted to be used only by special permission.

### D. Control and Protection of Appliances

**422-20. Disconnecting Means.** A means shall be provided to disconnect each appliance from all ungrounded conductors in accordance with the following sections of Part D. If an appliance is supplied by more than one source, the disconnecting means shall be grouped and identified.

**422-21. Disconnection of Permanently Connected Appliances.**

**(a) Rated at Not Over 300 Volt Amperes or 1/8 Horsepower.** For permanently connected appliances rated at not over 300 volt amperes or 1/8 horsepower, the branch-circuit overcurrent device shall be permitted to serve as the disconnecting means.

**(b) Permanently Connected Appliances of Greater Rating.** For permanently connected appliances of greater rating the branch-circuit switch or circuit breaker shall be permitted to serve as the disconnecting means where the switch or circuit breaker is within sight from the appliance or is capable of being locked in the open position.

(FPN No. 1): For motor-driven appliances of more than 1/8 horsepower, see Section 422-27.

(FPN No. 2): For appliances employing unit switches see Section 422-25.

**422-22. Disconnection of Cord- and Plug-Connected Appliances.**

**(a) Separable Connector or an Attachment Plug and Receptacle.** For cord- and plug-connected appliances, an accessible separable connector or an accessible plug and receptacle shall be permitted to serve as the disconnecting means. Other cord- and plug-connected appliances shall be provided with disconnecting means in accordance with Section 422-21.

**(b) Connection at the Rear Base of a Range.** For cord- and plug-connected household electric ranges, an attachment plug and receptacle connection at the rear base of a range, if it is accessible from the front by removal of a drawer, shall be considered as meeting the intent of Section 422-22(a).

**(c) Rating.** The rating of a receptacle or of a separable connector shall not be less than the rating of any appliance connected thereto.

*Exception: Demand factors authorized elsewhere in this Code shall be permitted to be applied.*

**422-23. Polarity in Cord- and Plug-Connected Appliances.** If the appliance is provided with a manually operated, line-connected single-pole switch for appliance on-off operation, an Edison-base lampholder or a 15- or 20-ampere receptacle, the attachment plug shall be of the polarized or grounding type.

(FPN): See also Section 410-42(a) of the NEC.

**422-24. Cord- and Plug-Connected Appliances Subject to Immersion.** Cord- and plug-connected portable free standing hydromassage units and hand-held hair dryers shall be constructed to provide protection for personnel against electrocution when immersed while in the "ON" or "OFF" position.

**422-25. Unit Switch(es) as Disconnecting Means.** A unit switch(es) with a marked "off" position that is a part of an appliance and disconnects all ungrounded conductors shall be permitted as the disconnecting means required by this article where other means for disconnection are provided in the following types of occupancies:

**(b) Two-Family Dwellings.** In two-family dwellings, the other disconnecting means shall be permitted either inside or outside of the dwelling unit in which the appliance is installed. In this case, an individual switch or circuit breaker for the dwelling unit shall be permitted and shall also be permitted to control lamps and other appliances.

**(c) One-Family Dwellings.** In one-family dwellings, the service disconnecting means shall be permitted to be the other disconnecting means.

**422-26. Switch and Circuit Breaker to Be Indicating.** Switches and circuit breakers used as disconnecting means shall be of the indicating type.

**422-27. Disconnecting Means for Motor-Driven Appliances.** If a switch or circuit breaker serves as the disconnecting means for a permanently connected motor-driven appliance of more than $\frac{1}{8}$ horsepower, it shall be located within sight from the motor controller and shall comply with Part H of Article 430 in the NEC.

*Exception: A switch or circuit breaker that serves as the other disconnecting means as required in Section 422-25, (b), or (c) shall be permitted to be out of sight from the motor controller of an appliance provided with a unit switch(es) with a marked "off" position and which disconnects all ungrounded conductors.*

**422-28. Overcurrent Protection.**

**(a) Appliances.** Appliances shall be protected against overcurrent in accordance with (b) through (f) below and Sections 422-4 and 422-5.

*Exception: Motors of motor-operated appliances shall be provided with overload protection in accordance with Part C of Article 430 in the NEC. Hermetic refrigerant motor-compressors in air-conditioning or refrigerating equipment shall be provided with overload protection in accordance with Part F of Article 440 in the NEC. When appliance overcurrent protective devices separate from the appliance are required, data for selection of these devices shall be marked on the appliance. The minimum marking shall be that specified in Sections 430-7 and 440-4 in the NEC.*

**(b) Household-type Appliance with Surface Heating Elements.** A household-type appliance with surface heating elements having a maximum demand of more than 60 amperes computed in accordance with Table 220-19 shall have its power supply subdivided into two or more circuits, each of which is provided with overcurrent protection rated at not over 50 amperes.

**(e) Single Nonmotor-Operated Appliance.** If the branch circuit supplies a single nonmotor-operated appliance, the rating of overcurrent protection shall: (1) not exceed that marked on the appliance; (2) if the overcurrent protection rating is not marked and the appliance is rated over 13.3 amperes, not exceed 150 percent of the appliance rated current; or (3) if the overcurrent protection rating is not marked and the appliance is rated 13.3 amperes or less, not exceed 20 amperes.

*Exception: Where 150 percent of appliance rating does not correspond to a standard overcurrent device ampere rating, the next higher standard rating shall be permitted.*

**(f) Electric Heating Appliances Employing Resistance-type Heating Elements Rated More than 48 Amperes.** Electric heating appliances employing resistance-type heating elements rated more than 48 amperes shall have the heating elements subdivided. Each subdivided load shall not exceed 48 amperes and shall be protected at not more than 60 amperes.

These supplementary overcurrent protective devices shall be: (1) factory installed within or on the heater enclosure or provided as a separate assembly by the heater manufacturer; (2) accessible, but need not be readily accessible; and (3) suitable for branch-circuit protection.

The main conductors supplying these overcurrent protective devices shall be considered branch-circuit conductors.

*Exception No. 1: Household-type appliances with surface heating elements as covered in Section 422-28(b).*

## E. Marking of Appliances

### 422-30. Nameplate.

**(a) Nameplate Marking.** Each electric appliance shall be provided with a nameplate, giving the identifying name and the rating in volts and amperes, or in volts and watts. If the appliance is to be used on a specific frequency or frequencies, it shall be so marked.

When motor overload protection external to the appliance is required, the appliance shall be so marked.

(FPN): See Section 422-28(a), Exception for overcurrent protection requirements.

**(b) To Be Visible.** Marking shall be located so as to be visible or easily accessible after installation.

**422-31. Marking of Heating Elements.** All heating elements that are rated over one ampere, replaceable in the field, and a part of an appliance shall be legibly marked with the ratings in volts and amperes, or in volts and watts, or with the manufacturer's part number.

**422-32. Appliances Consisting of Motors and Other Loads.** Appliances shall be marked in accordance with (a) or (b) below.

**(a) Marking.** In addition to the marking required in Section 422-30, the marking on an appliance consisting of a motor with other load(s) or motors with or without other load(s) shall specify the minimum supply circuit conductor ampacity and the maximum rating of the circuit overcurrent protective device.

*Exception No. 1: Appliances factory-equipped with cords and attachment plugs, complying with Section 422-30.*

*Exception No. 2: An appliance where both the minimum supply circuit conductor ampacity and maximum rating of the circuit overcurrent protective device are not more than 15 amperes and complies with Section 422-30.*

**(b) Alternate Marking Method.** An alternate marking method shall be permitted to specify the rating of the largest motor in volts and amperes, and the additional load(s) in volts and amperes, or volts and watts in addition to the marking required in Section 422-30.

*Exception No. 1: Appliances factory-equipped with cords and attachment plugs, complying with Section 422-30.*

*Exception No. 2: The ampere rating of a motor 1/8 horsepower or less or a nonmotor load 1 ampere or less shall be permitted to be omitted unless such loads constitute the principal load.*

## ARTICLE 424 – FIXED ELECTRIC SPACE HEATING EQUIPMENT

### A. General

**424-1. Scope.** This article covers fixed electric equipment used for space heating. For the purpose of this article, heating equipment shall include heating cable, unit heaters, boilers, central systems, or other approved fixed electric space heating equipment. This article shall not apply to process heating and room air conditioning.

**424-2. Other Articles.** All requirements of this Code shall apply where applicable. Fixed electric space heating equipment incorporating a hermetic refrigerant motor-compressor shall also comply with Article 440 in the NEC.

### 424-3. Branch Circuits.

**(a) Branch-Circuit Requirements.** Individual branch circuits shall be permitted to supply any size fixed electric space heating equipment.

Branch circuits supplying two or more outlets for fixed electric space heating equipment shall be rated 15, 20, or 30 amperes.

**(b) Branch-Circuit Sizing.** The ampacity of the branch-circuit conductors and the rating or setting of overcurrent protective devices supplying fixed electric space heating equipment consisting of resistance elements with or without a motor shall not be less than 125 percent of the total load of the motors and the heaters. The rating or setting of overcurrent protective devices shall be permitted in accordance with Section 240-3, Exception

No. 4. A contactor, thermostat, relay, or similar device, approved for continuous operation at 100 percent of its rating, shall be permitted to supply its full-rated load as provided in Section 210-22(c), Exception.

The size of the branch-circuit conductors and overcurrent protective devices supplying fixed electric space heating equipment including a hermetic refrigerant motor-compressor with or without resistance units shall be computed in accordance with Sections 440-34 and 440-35 in the NEC.

The provisions of this section shall not apply to conductors which form an integral part of approved fixed electric space heating equipment.

### B. Installation

**424-9. General.** All fixed electric space heating equipment shall be installed in an approved manner.

(FPN): Listed baseboard heaters include instructions that may not permit their installation below receptacle outlets.

**424-10. Special Permission.** Fixed electric space heating equipment and systems installed by methods other than covered by this article shall be permitted only by special permission.

**424-11. Supply Conductors.** Fixed electric space heating equipment requiring supply conductors with over 60°C insulation shall be clearly and permanently marked. This marking shall be plainly visible after installation and shall be permitted to be adjacent to the field-connection box.

**424-12. Locations.**

**(a) Exposed to Severe Physical Damage.** Fixed electric space heating equipment shall not be used where exposed to severe physical damage unless adequately protected.

**(b) Damp or Wet Locations.** Heaters and related equipment installed in damp or wet locations shall be approved for such locations and shall be constructed and installed so that water cannot enter or accumulate in or on wired sections, electrical components, or duct work.

(FPN No. 1): See Section 110-11 for equipment exposed to deteriorating agents.

(FPN No. 2): See Section 680-27 for pool deck areas.

**424-13. Spacing from Combustible Materials.** Fixed electric space heating equipment shall be installed to provide the required spacing between the equipment and adjacent combustible material, unless it has been found to be acceptable where installed in direct contact with combustible material.

**424-14. Grounding.** All exposed noncurrent-carrying metal parts of fixed electric space heating equipment likely to become energized shall be grounded as required in Article 250.

### C. Control and Protection of Fixed Electric Space Heating Equipment

**424-19. Disconnecting Means.** Means shall be provided to disconnect the heater, motor controller(s), and supplementary overcurrent protective device(s) of all fixed electric space heating equipment from all ungrounded conductors. Where heating equipment is supplied by more than one source, the disconnecting means shall be grouped and identified.

**(a) Heating Equipment with Supplementary Overcurrent Protection.** The disconnecting means for fixed electric space heating equipment with supplementary overcurrent protection shall be within sight from the supplementary overcurrent protective device(s), on the supply side of these devices, if fuses, and in addition shall comply with either (1) or (2) below.

**(1) Heater Containing No Motor Rated Over 1/8 Horsepower.** The above disconnecting means or unit switches complying with Section 424-19(c) shall be permitted to serve as the required disconnecting means for both the motor controller(s) and heater under either a. or b. below.

a. The disconnecting means provided is also within sight from the motor controller(s) and the heater; or

b. The disconnecting means provided shall be capable of being locked in the open position.

**(2) Heater Containing a Motor(s) Rated Over 1/8 Horsepower.** The above disconnecting means shall be permitted to serve as the required disconnecting means for both the motor controller(s) and heater by one of the means specified in a. and b. below.

a. Where the disconnecting means is also in sight from the motor controller(s) and the heater.

b. Where the disconnecting means is not within sight from the heater a separate disconnecting means shall be installed, or the disconnecting means shall be capable of being locked in the open position, or unit switches complying with Section 424-19(c) shall be permitted.

**(b) Heating Equipment Without Supplementary Overcurrent Protection.**

**(1) Without Motor or with Motor Not Over 1/8 Horsepower.** For fixed electric space heating equipment without a motor rated over 1/8 horsepower, the branch-circuit switch or circuit breaker shall be permitted to serve as the disconnecting means, where readily accessible for servicing.

**(2) Over 1/8 Horsepower.** For motor-driven electric space heating equipment with a motor rated over 1/8 horsepower, a disconnecting means shall be located within sight from the motor controller.

*Exception: As permitted by Section 424-19(a)(2).*

**(c) Unit Switch(es) as Disconnecting Means.** A unit switch(es) with a marked "off" position that is part of a fixed heater and disconnects all ungrounded conductors shall be permitted as the disconnecting means required by this article where other means for disconnection are provided in the following types of occupancies.

**(2) Two-Family Dwellings.** In two-family dwellings, the other disconnecting means shall be permitted either inside or outside of the dwelling unit in which the fixed heater is installed. In this case, an individual switch or circuit breaker for the dwelling unit shall be permitted and shall also be permitted to control lamps and appliances.

**(3) One-Family Dwellings.** In one-family dwellings, the service disconnecting means shall be permitted to be the other disconnecting means.

### 424-20. Thermostatically Controlled Switching Devices.

**(a) Serving as Both Controllers and Disconnecting Means.** Thermostatically controlled switching devices and combination thermostats and manually controlled switches shall be permitted to serve as both controllers and disconnecting means provided all of the following conditions are met:

**(1)** Provided with a marked "off" position.

**(2)** Directly open all ungrounded conductors when manually placed in the "off" position.

**(3)** Designed so that the circuit cannot be energized automatically after the device has been manually placed in the "off" position.

**(4)** Located as specified in Section 424-19.

**(b) Thermostats that Do Not Directly Interrupt All Ungrounded Conductors.** Thermostats that do not directly interrupt all ungrounded conductors and thermostats that operate remote control circuits shall not be required to meet the requirements of (a). These devices shall not be permitted as the disconnecting means.

**424-21. Switch and Circuit Breaker to Be Indicating.** Switches and circuit breakers used as disconnecting means shall be of the indicating type.

### 424-22. Overcurrent Protection.

**(a) Branch-Circuit Devices.** Electric space heating equipment, other than such motor-operated equipment as required by Articles 430 and 440 in the NEC to have additional overcurrent protection, shall be permitted to be protected against overcurrent where supplied by one of the branch circuits in Article 210.

**(b) Resistance Elements.** Resistance-type heating elements in electric space heating equipment shall be protected at not more than 60 amperes. Equipment rated more than 48 amperes and employing such elements shall have the heating elements subdivided, and each subdivided load shall not exceed 48 amperes. Where a subdivided load is less than 48 amperes the rating of the supplementary overcurrent protective device shall comply with Section 424-3(b).

**(c) Overcurrent Protective Devices.** The supplementary overcurrent protective devices for the subdivided loads specified in (b) above shall be: (1) factory installed within or on the heater enclosure or supplied for use with the heater as a separate assembly by the heater manufacturer; (2) accessible, but shall not be required to be readily accessible; and (3) suitable for branch-circuit protection.

(FPN): See Section 240-10 in the NEC.

Where cartridge fuses are used to provide this overcurrent protection, a single disconnecting means shall be permitted to be used for the several subdivided loads.

(FPN): See Section 240-40 in the NEC.

**(d) Branch-Circuit Conductors.** The conductors supplying the supplementary overcurrent protective devices shall be considered branch-circuit conductors.

*Exception: For heaters rated 50 kW or more, the conductors supplying the supplementary overcurrent protective devices specified in (c) above shall be permitted to be sized at not less than 100 percent of the nameplate rating of the heater provided all of the following conditions are met:*

*a. The heater is marked with a minimum conductor size; and*

*b. The conductors are not smaller than the marked minimum size; and*

*c. A temperature-actuated device controls the cyclic operation of the equipment.*

**(e) Conductors for Subdivided Loads.** Field-wired conductors between the heater and the supplementary overcurrent protective devices shall be sized at not less than 125 percent of the load served. The supplementary overcurrent protective devices specified in (c) shall protect these conductors in accordance with Section 240-3.

*Exception: For heaters rated 50 kW or more, the ampacity of field-wired conductors between the heater and the supplementary overcurrent protective devices shall be permitted to be not less than 100 percent of the load of their respective subdivided circuits provided all of the following conditions are met:*

*a. The heater is marked with a minimum conductor size; and*

*b. The conductors are not smaller than the marked minimum size; and*

*c. A temperature-activated device controls the cyclic operation of the equipment.*

## D. Marking of Heating Equipment

### 424-28. Nameplate.

**(a) Marking Required.** Each unit of fixed electric space heating equipment shall be provided with a nameplate giving the identifying name and the normal rating in volts and watts, or in volts and amperes.

Electric space heating equipment intended for use on alternating current only or direct current only shall be marked to so indicate. The marking of equipment consisting of motors over 1/8 horsepower and other loads shall specify the rating of the motor in volts, amperes, and frequency, and the heating load in volts and watts, or in volts and amperes.

**(b) Location.** This nameplate shall be located so as to be visible or easily accessible after installation.

**424-29. Marking of Heating Elements.** All heating elements that are replaceable in the field and are a part of an electric heater shall be legibly marked with the ratings in volts and watts, or in volts and amperes.

### E. Electric Space Heating Cables

**424-34. Heating Cable Construction.** Heating cables shall be furnished complete with factory-assembled nonheating leads at least 7 feet (2.13 m) in length.

**424-35. Marking of Heating Cables.** Each unit shall be marked with the identifying name or identification symbol, catalog number, ratings in volts and watts, or in volts and amperes.

Each unit length of heating cable shall have a permanent legible marking on each nonheating lead located within 3 inches (76 mm) of the terminal end. The lead wire shall have the following color identification to indicate the circuit voltage on which it is to be used: 120-volt nominal, yellow; 208-volt nominal, blue; 240-volt nominal, red; and 277-volt nominal, brown.

**424-36. Clearances of Wiring in Ceilings.** Wiring located above heated ceilings shall be spaced not less than 2 inches (50.8 mm) above the heated ceiling and shall be considered as operating at an ambient of 50°C (122°F). The ampacity of conductors shall be computed on the basis of the correction factors given in Table 310-16.

*Exception: Wiring above heated ceilings and located above thermal insulation having a minimum thickness of 2 inches (50.8 mm) shall not require correction for temperature.*

**424-37. Location of Branch-Circuit and Feeder Wiring in Exterior Walls.** Wiring methods shall comply with Article 300 and Section 310-10.

**424-38. Area Restrictions.**

**(a) Shall Not Extend Beyond the Room or Area.** Heating cables shall not extend beyond the room or area in which they originate.

**(b) Uses Prohibited.** Cables shall not be installed in closets, over walls or partitions that extend to the ceiling, or over cabinets whose clearance from the ceiling is less than the minimum horizontal dimension of the cabinet to the nearest cabinet edge that is open to the room or area.

*Exception: Isolated single runs of cable shall be permitted to pass over partitions where they are embedded.*

**(c) In Closet Ceilings as Low Temperature Heat Sources to Control Relative Humidity.** This provision shall not prevent the use of cable in closet ceilings as low temperature heat sources to control relative humidity, provided they are used only in those portions of the ceiling that are unobstructed to the floor by shelves or other permanent fixtures.

**424-39. Clearance from Other Objects and Openings.** Heating elements of cables shall be separated at least 8 inches (203 mm) from the edge of outlet boxes and junction boxes that are to be used for mounting surface

lighting fixtures. A clearance of not less than 2 inches (50.8 mm) shall be provided from recessed fixtures and their trims, ventilating openings, and other such openings in room surfaces. Sufficient area shall be provided to assure that no heating cable will be covered by any surface-mounted units.

**424-40. Splices.** Embedded cables shall be spliced only where necessary and only by approved means, and in no case shall the length of the heating cable be altered.

**424-41. Installation of Heating Cables on Dry Board, in Plaster and on Concrete Ceilings.**

**(a) Shall Not Be Installed in Walls.** Cables shall not be installed in walls.

*Exception: Isolated single runs of cable shall be permitted to run down a vertical surface to reach a dropped ceiling.*

**(b) Adjacent Runs.** Adjacent runs of cable not exceeding 2¾ watts per foot (305 mm) shall be installed not less than 1½ inches (38 mm) on centers.

**(c) Surfaces to Be Applied.** Heating cables shall be applied only to gypsum board, plaster lath or other fire-resistant material. With metal lath or other electrically conductive surfaces, a coat of plaster shall be applied to completely separate the metal lath or conductive surface from the cable.

(FPN): See also (f) below.

**(d) Splices.** All heating cables, the splice between the heating cable and nonheating leads, and 3-inch (76-mm) minimum of the nonheating lead at the splice shall be embedded in plaster or dry board in the same manner as the heating cable.

**(e) Ceiling Surface.** The entire ceiling surface shall have a finish of thermally noninsulating sand plaster having a nominal thickness of ½ inch (12.7 mm), or other noninsulating material identified as suitable for this use and applied according to specified thickness and directions.

**(f) Secured.** Cables shall be secured at intervals not exceeding 16 inches (406 mm) by means of approved stapling, tape, plaster, nonmetallic spreaders, or other approved means. Staples or metal fasteners that straddle the cable shall not be used with metal lath or other electrically conductive surfaces.

*Exception: Cables identified to be secured at intervals not to exceed 6 feet (1.83 m).*

**(g) Dry Board Installations.** In dry board installations, the entire ceiling below the heating cable shall be covered with gypsum board not exceeding ½ inch (12.7 mm) thickness. The void between the upper layer of gypsum board, plaster lath, or other fire-resistant material and the surface layer of gypsum board shall be completely filled with thermally conductive nonshrinking plaster or other approved material or equivalent thermal conductivity.

**(h) Free from Contact with Conductive Surfaces.** Cables shall be kept free from contact with metal or other electrically conductive surfaces.

**(i) Joists.** In dry board applications, cable shall be installed parallel to the joist, leaving a clear space centered under the joist of 2½ inches (64 mm) (width) between centers of adjacent runs of cable. Surface layer of gypsum board shall be mounted so that the nails or other fasteners do not pierce the heating cable.

**(j) Crossing Joists.** Cables shall cross joists only at the ends of the room.

*Exception: Where the cable is required to cross joists elsewhere in order to satisfy the manufacturer's instructions that the installer avoid placing the cable too close to ceiling penetrations and light fixtures.*

**424-42. Finished Ceilings.** Finished ceilings shall not be covered with decorative panels or beams constructed of materials which have thermal insulating properties, such as wood, fiber, or plastic. Finished ceilings shall be permitted to be covered with paint, wallpaper, or other approved surface finishes.

**424-43. Installation of Nonheating Leads of Cables.**

**(a) Free Nonheating Leads.** Free nonheating leads of cables shall be installed in accordance with approved wiring methods from the junction box to a location within the ceiling. Such installations shall be permitted to be single conductors in approved raceways, single or multiconductor Type UF, Type NMC, Type MI, or other approved conductors.

**(b) Leads in Junction Box.** Not less than 6 inches (152 mm) of free nonheating lead shall be within the junction box. The marking of the leads shall be visible in the junction box.

**(c) Excess Leads.** Excess leads of heating cables shall not be cut but shall be secured to the underside of the ceiling and embedded in plaster or other approved material, leaving only a length sufficient to reach the junction box with not less than 6 inches (152 mm) of free lead within the box.

**424-44. Installation of Cables in Concrete or Poured Masonry Floors.**

**(a) Watts per Linear Foot.** Heating cables shall not exceed 16½ watts per linear foot (305 mm) of cable.

**(b) Spacing Between Adjacent Runs.** The spacing between adjacent runs of cable shall not be less than 1 inch (25.4 mm) on centers.

**(c) Secured in Place.** Cables shall be secured in place by nonmetallic frames or spreaders or other approved means while the concrete or other finish is applied.

Cables shall not be installed where they bridge expansion joints unless protected from expansion and contraction.

**(d) Spacings Between Heating Cable and Metal Embedded in the Floor.** Spacings shall be maintained between the heating cable and metal embedded in the floor.

*Exception: Grounded metal-clad cable shall be permitted to be in contact with metal embedded in the floor.*