NFPA

70A

1978

ELECTRICAL CODE FOR

ONE- AND TWO-FAMILY DWELLINGS

Excerpted from the
1978 National Electrical Code

470 Atlantic Avenue Boston, MA 02210

Official Interpretations

The Committee responsible for this document will render official interpretations of the literal text and of the intent of the Committee when the text was adopted.

A request for an Official Interpretation shall be directed to the Chairman of the Committee concerned, at the National Fire Protection Association, 470 Atlantic Avenue, Boston, Massachusetts 02210, supplying five identical copies of a statement in which shall appear specific references to a single problem, and identifying the portion of the document (article, section, paragraph, etc.) for which the interpretation is requested. Such a request shall be on the business stationery of the requester and shall be duly signed. A request involving an actual field situation shall so state and all parties involved shall be named.

Statement on NFPA Procedures

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See Official NFPA Definitions at the back of this pamphlet.

NFPA Standard Electrical Code for One- and Two-Family Dwellings

NFPA 70A - 1978

Excerpted from the 1978 National Electrical Code

NFPA 70 - 1978

Explanation of this Code

This Electrical Code for One- and Two-Family Dwellings (NFPA 70A-1978) 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 1978 National Electrical Code (NFPA 70-1978) 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 as to format and content, the excerpted material containing editorial revision was formally submitted to members of the Technical Committee and the Correlating Committee for letter ballot to determine if the editorial changes accomplished had been achieved without altering the intent of the complete Code.

Technical Subcommittee for NFPA Standard Electrical Code for One- and Two-Family Dwellings

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NFPA Standard Electrical Code for One- and Two-Family Dwellings

Excerpted from the 1978 National Electrical Code
NFPA No. 70A-1978

(For rules covering wiring methods and equipment not included here, see the 1978 National Electrical Code.)

PREFACE

This Code has been prepared under the guidance of a Technical Subcommittee (see page 70A-iii) 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 1978 National Electrical Code (NFPA 70-1978) 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 1978 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 1978 National Electrical Code.

The rules in this Code have been excerpted from the 1978 National Electrical Code, but editorially revised where necessary to restrict their applicability to 1- and 2-family dwellings. Where such rules have been editorially revised, they are listed in a resume that follows the index.

The section numbers assigned to these rules are the same as in the 1978 National Electrical Code. However, there are many paragraphs in the 1978

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 concurrently with each revised edition of the National Electrical Code to insure that there is no divergence between the requirements of the Codes as they pertain to 1- and 2-family dwellings.

NFPA Standard Electrical Code for One- and Two-Family Dwellings

NFPA 70A-1978

ARTICLE 90 — INTRODUCTION

90-1. Purpose.

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

(b) 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.

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) 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 1978 National Electrical Code (NFPA 70-1978) are also recognized by this Code.

(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.

(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.

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

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.

90-5. Formal Interpretations. To promote uniformity of interpretation and application of the provisions of this Code, the National Electrical Code Committee has established interpretation procedures.

90-6. Examination of Equipment for Safety. For specific items of equipment and materials covered by 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 an electrical testing laboratory that is nationally recognized as having the facilities described above and which requires suitability for installation in accordance with this Code.

See Examination of Equipment, Section 110-3.

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.

110-3. Examination, 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 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.

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 those wiring methods most commonly

encountered in 1- and 2-family dwellings are included in this Code. The recognized methods of wiring shall be permitted to be installed in 1- and 2-family dwellings. Other wiring methods recognized by the NEC for 1- and 2-family dwellings are also recognized under this Code.

110-9. Interrupting Capacity. Devices intended to break current shall have an interrupting capacity sufficient for the voltage employed and 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 approved for the purpose, 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.

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.

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 suitable 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 suitable 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.

(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 of a type approved for the purpose.

(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 or Less, Nominal). 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 or less and likely to require examination, adjustment, servicing, or maintenance while alive shall not be less than indicated in Table 110-16(a). In addition to the dimensions shown in Table 110-16(a), the work space shall not be less than 30 inches wide in front of the electric equipment. Distances shall be measured from the live parts if such are exposed or from the enclosure front or opening if such are enclosed. Concrete, brick, or tile walls shall be considered as grounded.

Table 110-16(a). Working Clearances

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

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 where it is judged that the particular arrangement of the installation will provide adequate accessibility.

(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 or less, nominal)

(a) 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 cabinets or other forms of 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.

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, 250-5, 250-3, and 250-7 in the NEC.

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

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 connection 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.

Exception No. 1: The grounded conductor of a mineral-insulated metal-sheathed cable shall be identified at the time of installation by distinctive marking at its terminations.

(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.

(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 outlet 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: Single-pole devices to which only one side of the line is connected.

Exception No. 3: The terminals of lighting and appliance branch-circuit panelboards.

Exception No. 4: 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) Plugs, Receptacles, 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 by a metal or metal coating substantially white in color.

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

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.

Exception: Two-wire attachment plugs shall not be required to have their terminals marked for identification.

(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 to be connected (1) by permanent wiring methods or (2) by field-installed plugs and cords with three or more wires shall have marking to identify the terminal for the grounded circuit conductor.

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. The provisions of this article apply to branch circuits supplying lighting or appliance loads or combinations of both. Where motors or motor-operated appliances are connected to any branch circuit that also supplies lighting or other appliance loads, the provisions of both this article and Article 430 in the NEC shall apply. Article 430 in the NEC applies where a branch circuit supplies motor loads only.

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:

Class 1, Class 2, and Class 3 Remote Control,
Signaling, and Power-limited Circuits ..... Article 725
Fixed Electric Space Heating Equipment ..... Section 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. Branch circuits recognized by this article shall be permitted as multiwire circuits. 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.

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 or different systems are installed in the same raceway, box, auxiliary gutter, or other types of enclosures, one system neutral, if required, shall have an outer covering of white or natural gray. Each other system neutral, 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) Grounding Conductor. The 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 (in the NEC) and Section 310-10(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. Maximum Voltage.

(a) Voltage to Ground. Branch circuits supplying lampholders, fixtures, or standard receptacles rated 15 amperes or less shall not exceed 150 volts to ground.

(c) Voltage Between Conductors.

(1) The voltage shall not exceed 150 volts between conductors on branch circuits supplying screw-shell lampholders, receptacles, or appliances in dwelling unit(s).

Exception No. 1: Permanently connected appliances.

Exception No. 2: Cord- and plug-connected loads of more than 1380 watts or ¼ horsepower or greater rating.

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).

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

(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.

Section 250-91(b) describes acceptable grounding means.

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 a nongrounding type of receptacle shall be used.

(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.

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.

(g) Receptacles rated 20-amperes or less directly connected to aluminum conductors shall be approved for the purpose and marked CO/ALR.

210-8. Ground-Fault Circuit Protection.

(a) Dwelling Units.

(1) All 120-volt, single-phase, 15- and 20-ampere receptacles installed in bathrooms and garages of dwelling units shall have ground-fault circuit-interrupter protection for personnel.

(2) All 120-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.

Bathroom: A bathroom is an area including a basin with one or more of the following: a toilet, a tub, or a shower.

Such ground-fault circuit-interrupter protection may be provided for other circuits, locations, and occupancies, and where used, will provide additional protection against line-to-ground shock hazard.

See Section 215-9 for feeder protection.

(b) Construction Sites. All 120-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 employees, shall have ground-fault circuit-interrupters for personnel protection.

Exception No. 1: Receptacles on a portable or vehicle-mounted generator rated not more than 5 kW, where the circuit conductors are insulated from the generator frame as permitted in Section 250-6 in the NEC.

Exception No. 2: Where a written procedure, acceptable to the authority having jurisdiction, is continuously enforced by a designated individual at the construction site to indicate that equipment grounding conductors for 120-volt, single-phase, 15- and 20-ampere receptacles, flexible cord sets, 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 305-2(d). The procedure shall include electrical continuity tests of all required equipment, grounding conductors and their connections. These tests shall be conducted as follows:

a. Fixed receptacles shall be tested where there is evidence of damage.

b. Flexible cord sets (extension cords) shall be tested before first use on the construction site. All flexible cord sets shall be tested where there is evidence of damage, and after any repairs.

c. Equipment connected by cord and plug shall be tested: (1) before first use on the construction site; (2) where there is evidence of damage; (3) after any repairs; and (4) at intervals not exceeding 3 months.

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; 424-20 for a fixed electric space heating unit; 426-21 in the NEC for electric de-icing and snow-melting equipment; 430-85 in the NEC for a motor controller; and 430-103 in the NEC for a motor.

B. Specific Requirements

210-19. Conductors — Minimum Ampacity and Size.

(a) General. Branch-circuit conductors shall have an ampacity of not less than the rating of the branch circuit and not less than the maximum load to be served. Cable assemblies with the neutral conductor smaller than the ungrounded conductors shall be so marked.

See Table 310-16 for ampacity ratings of conductors.

See Part B of Article 430 in the NEC for minimum rating of motor branch-circuit conductors.

Conductors for branch circuits as defined in Article 100 in the NEC 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(c) 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. The minimum size shall not be smaller than No. 8 for ranges of 8¾ kW or more rating.

Exception No. 1: 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 ampacity of the ungrounded conductors and shall not be smaller than No. 10.

Exception No. 2: 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 be no longer than necessary for servicing the appliance.

(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 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 long.
d. Infrared lamp industrial heating appliances.
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.

210-20. Overcurrent Protection.

(a) General. 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: Tap conductors, fixture wire, and cords as permitted in Section 210-19(c) shall be considered as being protected by the circuit overcurrent device.

See Section 240-1 for the purpose of overcurrent protection and Sections 210-22 and 220-2 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 (a) and (b) below.

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

(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.

See definition of Receptacle in Article 100 in the NEC.

(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).

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

(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).

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

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

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 in the NEC 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 ⅛ hp 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. Continuous loads, such as store lighting and similar loads, shall not exceed 80 percent of the rating of the branch circuit.

Exception No. 1: Motor loads having demand factors computed in accordance with Article 430 in the NEC.

Exception No. 2: Circuits that have been derated in accordance with Note 8 to Table 310-16.

Exception No. 3: Circuits supplied by an assembly together with its overcurrent devices that is listed for continuous operation at 100 percent of its rating.

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. It shall be acceptable for an individual branch circuit 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, appliances, or a combination of both. The rating of any one cord- and plug-connected appliance shall not exceed 80 percent of the branch-circuit ampere rating. The total rating of appliances fastened in place shall not exceed 50 percent of the branch-circuit ampere rating where lighting units, cord- and plug-connected appliances not fastened in place, or both, are also supplied.

Exception: The small appliance branch circuits required in a dwelling unit(s) by Section 220-3(b) shall supply only the receptacle outlets specified in that section.

(b) 25- and 30-Ampere Branch Circuits. A 25- or 30-ampere branch circuit shall be permitted to supply fixed lighting units with heavy-duty lampholders in other than dwelling unit(s) or appliances in any occupancy. A rating of any one cord- and plug-connected appliance 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 fixed lighting units with heavy-duty lampholders or infrared heating units in other than dwelling units or cooking appliances that are fastened in place in any occupancy.

210-24. Branch-Circuit Requirements — Summary. The requirements for circuits having two or more outlets, other than the receptacle circuits of

Table 210-24

Summary of Branch-Circuit Requirements

(Type FEP, FEPB, RUW, SA, T, TW, RH, RUH, 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 ampacities are for copper conductors where derating is not required. See Table 310-16.

** For receptacle rating of cord-connected electric-discharge lighting fixtures see Section 410-14.

Section 220-3(b) as specifically provided for above, are summarized in Table 210-24.

210-25. Receptacle Outlets Required. Receptacle outlets shall be installed where specified in (a) and (b) below.

A cord connector that is supported by a permanently connected cord pendant shall be considered a receptacle outlet.

(a) General. Where flexible cords are used.

Exception: Where flexible cords are specifically permitted to be permanently connected, and are so connected in boxes or fittings approved for the purpose, it shall be acceptable to omit receptacles on such equipment.

See Article 400 for use and installation of flexible cords.

(b) Dwelling Unit. In every kitchen, family room, dining room, breakfast room, living room, parlor, library, den, sun room, bedroom, recreation room, or similar rooms, receptacle outlets shall be installed so that no point along the floor line in any wall space is more than 6 feet, measured horizontally, from an outlet in that space, including any wall space 2 feet or more in width and the wall space occupied by 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 measurement.

In kitchen and dining areas a receptacle outlet shall be installed at each counter space wider than 12 inches. Counter top spaces separated by range tops, refrigerators, or sinks shall be considered as separate countertop spaces. Receptacles rendered inaccessible by appliances fastened in place or appliances occupying dedicated space shall not be considered as these required outlets.

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.

At least one wall receptacle outlet shall be installed in the bathroom adjacent to the basin location. See 210-8(a).

For a one-family dwelling, at least one receptacle outlet shall be installed outdoors.

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.

Outlets in other sections of the dwelling unit for special appliances, such as laundry equipment, shall be placed within 6 feet of the intended location of the appliance.

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.

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 two or more feet 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.

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

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 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.

210-26. Lighting Outlets Required. Lighting outlets shall be installed where specified in (a) below.

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

A vehicle door in an attached garage is not considered as an outdoor entrance.

At least one lighting outlet shall be installed in an attic, underfloor space, utility room and basement only where these spaces are used for storage or containing equipment requiring servicing.

Exception No. 1: In habitable rooms, other than kitchens, 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. The requirements of Section 215-8 in the NEC shall apply to feeders and other applications where identification is equally necessary.

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 one-family dwelling or a mobile home 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 feeder conductors shall not be smaller than No. 10 where the load supplied consists 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; (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 No. 6 or smaller.

(c) Overloaded Feeders. Where at any time feeder conductors are or will be overloaded the feeder conductors shall be increased in ampacity to accommodate the actual load served.

See Examples 1, 1(a), 1(b), 1(c), and 1(d), Tables and Examples.

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

215-6. Feeder Conductor Grounding Means. Where a feeder supplies branch circuits in which grounding conductors are required, the feeder shall include or provide a grounding means to which the 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 may 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 Personnel Protection. Feeders supplying 15- and 20-ampere receptacle branch circuits shall be permitted to be protected by a ground-fault circuit-interrupter approved for the purpose in lieu of the provisions for such interrupters as specified in Section 210-8.

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. Computation of Branch Circuits. Branch-circuit loads shall be computed as shown in (b) through (d) below.

(b) Lighting Load for Listed Occupancies. A unit load of not less than that specified in Table 220-2(b) in the NEC for occupancies listed therein shall constitute the minimum lighting load for each square foot 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.

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.

(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 in the NEC.

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

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

For receptacle outlets, each single or multiple receptacle 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 220-3(b) nor to receptacle outlets provided for the connection of cord- and plug-connected equipment as provided for in Section 400-7.

Exception No. 2: Table 220-19 shall be considered as an acceptable method of computing the load for a household electric range.

(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, 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.

220-3. 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 220-2. In addition, branch circuits shall be provided for specific loads not covered by Section 220-2 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.

(1) 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 210-25(b) for the small appliance loads, including refrigeration equipment, in the kitchen, pantry, breakfast room, dining room, and family room of a dwelling unit. Such circuits, whether two or more are used, shall have no other outlets.

Exception: A receptacle installed solely for the electric supply to and support of an electric clock in any of these stipulated rooms or outdoor receptacle outlets shall be supplied either by a small appliance branch circuit or by a general purpose branch circuit.

(2) Receptacle outlets installed in the kitchen 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 other rooms specified in (1) above. Additional small appliance branch circuits shall be permitted to supply receptacle outlets in such other rooms.

(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 210-25(b). This circuit shall have no other outlets.

(d) Load Evenly Proportioned Among Branch Circuits. Where the load is computed on a watts-per-square foot basis, the load, insofar as practical, shall be evenly proportioned among the branch circuits according to their capacities.

See Examples 1, 1(a), 1(b), 1(c), and 1(d), 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 and C have been applied.

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.

See Sections 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 (wattage)	Demand Factor Percent
Dwelling Units	First 3000 or less at	100
	Next 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.

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. In a multifamily dwelling the use of the optional calculation in Section 220-32 in the NEC shall be permitted.

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 watts for each 2-wire small appliance branch circuit required by Section 220-3(b) for small appliances supplied by 15-or 20-ampere receptacles on 20-ampere branch circuits in the kitchen, pantry, dining room, breakfast room, and family room. Where the load is subdivided through two or more feeders, the computed load for each shall include not less than 1500 watts for each 2-wire branch circuit for small appliances. These loads shall be permitted for 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 watts shall be included for each 2-wire laundry branch circuit installed as required by Section 220-3(c). It shall be permissible to include this load with the general lighting load and subjected to the demand factors provided in Section 220-11.

220-17. Fixed 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, two-family or multifamily 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 or the nameplate rating, whichever is larger, for each dryer served. The use of the demand factors in Table 220-18 shall be permitted.

Table 220-18

Demand Factors for Household Electric Clothes Dryers

Number of Dryers	Demand Factor Percent
1	100
2	100

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.

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%

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 12 kW through 27 kW ranges of *unequal ratings*. For ranges individually rated more than 12 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.

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 connected load between the neutral and any one ungrounded conductor, except that the load thus obtained shall be multiplied by 140 percent for 5-wire, 2-phase systems. For a feeder supplying household electric ranges, wall-mounted ovens, and counter-mounted cooking units, 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 3-wire DC or single-phase AC, 4-wire, 3-phase, and 5-wire, 2-phase systems, a further demand factor of 70 percent shall be permitted for that portion of the unbalanced load in excess of 200 amperes. There shall be no reduction of the neutral capacity for that portion of the load which consists of electric-discharge lighting.

See Examples 1, 1(a), 1(b), 1(c), and 1(d) Tables and Examples.

C. Optional Calculations for Computing Feeder and Service Loads

220-30. Optional Calculation — Dwelling Unit. For a dwelling unit having the total connected load served by a single 3-wire, 115/230-volt or 120/208 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. The loads identified in Table 220-30 as "other load" and as "Remainder of other load" shall include the following:

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

(2) 3 watts per square foot for general lighting and general-use receptacles.

(3) The nameplate rating of all fixed appliances, ranges, wall-mounted ovens, counter-mounted cooking units, and including four or more separately controlled space heating units.

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

(5) When applying Section 220-21 use the largest of the following: (1) Air-conditioning load; (2) The 65 percent diversified demand of the central electric space heating load; (3) The 65 percent diversified demand of the load of less than four separately-controlled electric space heating units; (4) The connected load of four or more separately-controlled electric space heating units.

Table 220-30

Optional Calculation for Dwelling Unit

Load (In kW or kVA)	Demand Factor Percent
Air conditioning and cooling, including heat pump compressors	100
Central electric space heating	65
Less than four separately controlled electric space heating units	65
First 10 kW of all other load	100
Remainder of other load	40

220-31. Optional Calculation for Additional Loads in Existing Dwelling Unit. For an existing dwelling unit presently being served by an existing 115/230 volt or 120/208, 3-wire, 60-ampere service, it shall be permissible to compute load calculations as follows:

Load (In kW or kVA)	Percent of Load
First 8 kW of load at	100%
Remainder of load at	40%

Load calculation shall include lighting at 3 watts per square foot; 1500 watts 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%

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

First 8 kW of all other load 100%
Remainder of all other load 40%

Other loads shall include:

1500 watts for each 20-ampere appliance circuit.

Lighting and portable appliances at 3 watts per sq. ft.

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.

ARTICLE 230 — SERVICES

A. General

230-1. Scope. This article covers service conductors and equipment for control and protection of services; the number, types, and sizes of services and service equipment; and the installation requirements.

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

Exception No. 3:

b. A two-family dwelling shall be permitted to have two or more separate sets of service-entrance conductors which are tapped from one service drop or lateral, or two or more sub-sets of service-entrance conductors shall be permitted to be tapped from a single set of main service-entrance conductors.

DEFINITION: Sub-sets of service-entrance conductors are taps from main service conductors run to service equipment.

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.

Exception: Where the buildings or other structures served are under single occupancy or management.

See Section 230-44 for masonry-encased conductors considered outside of a building.

B. Insulation and Size of Service Conductors

230-4. Insulation of Service Conductors. Service conductors shall normally withstand exposure to atmospheric and other conditions of use without detrimental leakage of current.

For Service Drops — See Section 230-22.
For Underground Services — See Section 230-30.
For Service-Entrance Conductors — See Section 230-40.

230-5. Size of Service Conductors. Service conductors shall have adequate ampacity to conduct safely the current for the loads supplied without a temperature rise detrimental to the insulation or covering of the conductors, and shall have adequate mechanical strength.

Minimum sizes are given in the following references:
For Service Drops — See Section 230-23.
For Underground Service Conductors — See Section 230-31.
For Service-Entrance Conductors — See Section 230-41.

C. Overhead Services

230-21. Overhead Supply. Overhead conductors to a building or other structure from another 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.

(a) Cable. Individual conductors of multiconductor cable shall be insulated or covered with thermoplastic or vulcanizable material.

Exception: A grounded conductor shall be permitted to be bare.

(b) Open Wiring. Individual conductors shall be insulated or covered.

230-23. Size and Rating. Conductors shall have sufficient ampacity to carry the load. They shall have adequate mechanical strength and 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.

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

230-24. Clearances. Service-drop conductors shall not be readily accessible and shall comply with (a) through (c) below for services not over 600 volts.

(a) Over Roofs. Conductors shall have a clearance of not less than 8 feet from the highest point of roofs over which they pass.

Exception No. 1: Where the voltage between conductors does not exceed 300 and the roof has a slope of not less than 4 inches in 12 inches, a reduction in clearance to 3 feet shall be permitted.

Exception No. 2: Where the voltage between conductors does not exceed 300, a reduction in clearance over the roof to not less than 18 inches shall be permitted if (1) they do not pass over more than 4 feet of the overhang portion of the roof, and (2) they are terminated at a through-the-roof raceway or approved support.

See Section 230-28 for mast supports.

(b) Clearance From Ground. Service-drop conductors when not in excess of 600 volts, shall have the following minimum clearance from ground:

10 feet — above finished grade, sidewalks or from any platform or projection from which they might be reached;

12 feet — over residential driveways and commercial areas such as parking lots and drive-in establishments not subject to truck traffic;

18 feet — over public streets, alleys, roads and driveways on other than residential property.

(c) Clearance from Building Openings. Conductors shall have a clearance of not less than 3 feet from windows, doors, porches, fire escapes, or similar locations.

Conductors run above the top level of a window shall be considered out of reach from that window.

230-26. Point of Attachment. The point of attachment of 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 above finished grade.

230-27. Means of Attachment. Multiconductor cables used for service drops shall be attached to buildings or other structures by fittings approved for the purpose. Open conductors shall be attached to fittings approved for the purpose 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 approved for the purpose.

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.

D. Underground Services

230-30. Insulation. 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 an approved cable assembly with a moisture- and fungus- resistant outer covering.

d. Aluminum or copper-clad aluminum without individual insulation or covering when part of a cable assembly approved for the purpose and having a moisture- and fungus-resistant outer covering when used in a raceway or for direct burial.

230-31. Size and Rating. Conductors shall have sufficient ampacity to carry the load. They shall not be smaller than No. 8 copper or No. 6 aluminum or copper-clad aluminum. The grounded conductor shall not be less than the minimum size required by Section 250-23(b).

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.

E. Service-Entrance Conductors

230-40. Insulation of Service-Entrance Conductors.

(a) Service-entrance conductors entering buildings or other structures

shall be insulated. Where only on the exterior of buildings or other structures the conductors shall be insulated or covered.

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 where part of an approved cable assembly with a moisture- and fungus- resistant outer covering.

d. Aluminum or copper-clad aluminum without individual insulation or covering when part of a cable assembly approved for the purpose and having a moisture- and fungus-resistant outer covering when used in a raceway or for direct burial.

(b) Open individual conductors which enter the building or other structure shall be covered with thermoplastic or vulcanizable material.

230-41. Size and Rating.

(a) General. Conductors shall be of sufficient size to carry the loads as computed in accordance with Article 220. Ampacity shall be determined from Table 310-16 and all applicable notes to this table.

(b) Ungrounded Conductors. Ungrounded conductors shall not be smaller than:

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

(2) 100-ampere, 3-wire, for a one-family dwelling with an initial computed load of 10 kW 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).

F. Installation of Service Conductors

230-43. Wiring Methods for 600 Volts 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) rigid metal conduit; (2) intermediate metal conduit;

(3) electrical metallic tubing; (4) service-entrance cables; (5) wireways; (6) auxiliary gutters; (7) nonmetallic conduit.

230-44. 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 of concrete beneath a building or other structure, or (2) where installed within a building or other structure in a raceway that is enclosed by concrete or brick not less than 2 inches thick.

230-45. Separate Enclosures. Where two to six service disconnecting means in separate enclosures 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.

230-46. 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.

230-47. Other Conductors in Raceway or Cable. Conductors other than service conductors shall not be installed in the same service raceway or service-entrance cable.

Exception No. 1: Grounding conductors.

Exception No. 2: Time switch conductors having overcurrent protection.

230-48. 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.

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

230-50. Protection of Open Conductors and Cables Against Damage — Above Ground. 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 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 8 feet of grade level or where exposed to physical damage.

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 of every service head, gooseneck, or connection to a raceway or enclosure and at intervals not exceeding 4½ feet.

(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 and in a manner that will maintain a clearance of not less than 2 inches 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.

230-54. Connections at Service Head.

(a) Service raceways shall be equipped with a raintight service head.

(b) 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 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 from the point of attachment.

(d) Service cables shall be held securely in place by connection to service-drop conductors below the gooseneck or by a fitting approved for the purpose.

(e) Service heads shall have conductors of opposite polarity brought out through separately bushed holes.

(f) 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) 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 live metal parts.

G. Service Equipment — Guarding and Grounding

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

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

(b) Guarded. Live 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 giving access to live 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.

H. 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. Each such disconnecting device shall be permanently marked to identify it as a service disconnecting means and shall be of a type that is suitable for use as service equipment under prevailing conditions.

230-71. Maximum Number of Disconnects.

(a) General. The service disconnecting means for each set or for each sub-set of service-entrance conductors 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.

(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.

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

230-72. Grouping of Disconnects.

(a) Sets of Disconnects. Where supplied by one service drop or service lateral, the two to six service disconnecting means permitted in Section 230-71 shall be grouped and each marked to indicate the load it serves.

Exception No. 2: 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) Location. The service disconnecting means shall be installed either inside or outside of a building or other structure at a readily accessible location nearest the point of entrance of the service-entrance conductors.

(d) In a two-family building, each occupant shall have access to his disconnecting means. A multiple-occupancy building having individual occupancy above the second floor shall have service equipment grouped in a common accessible location.

The disconnecting means shall consist of not more than six switches or six circuit breakers.

Two-family buildings that do not have individual occupancy above the second floor shall be permitted to have service conductors run to each occupancy in accordance with Section 230-2, Exception No. 3 and each such service may have not more than six switches or six circuit breakers.

230-73. Working Space. Sufficient working space shall be provided in the vicinity of the service disconnecting means to permit safe operation, inspection, and repairs. In no case shall this be less than that specified by Section 110-16.

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

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 disconnecting means for ungrounded conductors shall consist of a manually operable switch or circuit breaker equipped with a handle or other suitable operating means.

230-77. Indicating. The 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 live parts.

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 kW 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: Service fuses.

Exception No. 2: Fuses and disconnecting means or circuit breakers, in meter pedestals, 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. 4: Instrument transformers (current and potential), high-impedance shunts, surge-protective capacitors, time switches, and lightning arresters.

Exception No. 5: Taps used only to supply time switches, 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.

See Sections 230-72(c) and (d) for location.

(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.

J. Service Equipment — Overcurrent Protection

230-90. Where Required. Each ungrounded service-entrance conductor shall have overcurrent 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. 2: Fuses and circuit breakers with a rating or setting in conformity with Section 240-3, Exception No. 1, 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.

Exception No. 4: Each occupant shall have access to his overcurrent protective devices. A two-family dwelling having individual occupancy above the second floor shall have service equipment grouped in a common accessible location. The overcurrent protection shall consist of not more than six circuit breakers or six sets of fuses.

Two-family dwellings that do not have individual occupancy above the second floor shall be permitted to have service conductors run to each occupancy and each such service shall not have more than six circuit breakers or six sets of fuses.

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.

(c) More Than One Building. In a property comprising more than one building under single management, the ungrounded conductors supplying each building served shall be protected by overcurrent devices, which may be located in the building served or in another building on the same property, provided they are accessible to the occupants of the building served.

230-91. Location. The service overcurrent device shall be an integral part of the service disconnecting means or shall be located immediately adjacent thereto, unless located at the outer end of the entrance.

230-92. Location of Branch-Circuit Overcurrent Devices. Where the service overcurrent devices are locked or sealed, or otherwise not readily accessible, branch-circuit overcurrent devices shall be installed on the load side, shall be mounted in an accessible location, and shall be of lower rating than the service overcurrent device.

230-94. Relative Location of Overcurrent Device and Other Service Equipment. The overcurrent device shall protect all circuits and devices.

Exception No. 1: The service switch shall be permitted on the supply side.

Exception No. 2: High-impedance shunt circuits, lightning arresters, surge protective capacitors, instrument transformers (current and potential), shall be permitted to be connected and installed on the supply side of the service disconnecting means as permitted in Section 230-82.

Exception No. 3: Circuits for emergency supply and time switches shall be permitted to be connected on the supply side of the service overcurrent device where separately provided with overcurrent protection.

Exception No. 4: Circuits used only for the operation of fire alarm, other protective signaling systems, or the supply to fire pump equipment shall be permitted to be connected on the supply side of the service overcurrent device where separately provided with overcurrent protection.

Exception No. 5: Meters nominally rated not in excess of 600 volts, provided all metal housings and service enclosures are grounded in accordance with Article 250.

230-96. Working Space. Sufficient working space shall be provided in the vicinity of the service overcurrent devices to permit safe operation, replacements, inspection, and repairs. In no case shall this be less than that specified by Section 110-16.

230-98. Available Short-Circuit Current. Service equipment shall be suitable for the short-circuit current available at its supply terminals.

ARTICLE 240 — OVERCURRENT PROTECTION

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

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.

Equipment	Article No.
Appliances	422
Class 1, Class 2, and Class 3 Remote Control, Signaling, and Power-Limited Circuits	725
Fixed Electric Heating Equipment for Pipelines and Vessels	427
Panelboards	384
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: 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.

Exception No. 2: Tap Conductors. Tap conductors as permitted in Sections 210-19(c); 240-21, Exception Nos. 2, 3, 5, and 8; 364-10 and 364-11; and Part D of Article 430 in the NEC.

240-4. Protection of Fixture Wires and Cords. Fixture wire or flexible cord, size No. 16 or No. 18, and tinsel cord shall be considered as protected by 20-ampere overcurrent devices.

Flexible cord approved for use with specific appliances shall be considered as protected by the overcurrent device of the branch circuit of Article 210 when conforming to the following:

20-ampere circuits, No. 18 cord and larger.
30-ampere circuits, cord of 10-ampere capacity and over.
40-ampere circuits, cord of 20-ampere capacity and over.
50-ampere circuits, cord of 20-ampere capacity and over.

Fixture wire shall be considered as protected by the overcurrent device of the branch circuit of Article 210 when conforming to the following:

20-ampere circuits, No. 18 and larger.
30-ampere circuits, No. 14 and larger.
40-ampere circuits, No. 12 and larger.
50-ampere circuits, No. 12 and larger.

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 for the purpose.

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.

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 conductor of ungrounded 2-wire circuits, each ungrounded conductor of 3-wire direct-current or single-phase circuits, or for each ungrounded conductor of lighting or appliance branch circuits connected to 4-wire 3-phase systems or 5-wire 2-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.

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 may 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.

Exception No. 1: For services as provided in Section 230-91.

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

(c) Not Exposed to 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.

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 of a type approved for the purpose and shall be mounted so there is at least ¼-inch 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 unless in individual instances this is shown to be impracticable.

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 (g) 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.

(g) Connections for lightning arresters.

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.

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:

	Article	Section
Appliances		422-16
Branch Circuits		210-5
		210-6
		210-7
Circuits and Equipment Operating at Less Than 50 Volts	720	
Class 1, Class 2, and Class 3 Circuits		725-20
		725-42
Conductors (Grounded)	200	
Fire Protective Signaling Systems		760-6
Fixed Electric Space Heating Equipment		424-14
Fixtures and Lighting Equipment		410-17
		410-18
		410-21

	Article	Section
Grounding-Type Receptacles (Outlets)		210-7
Lighting Fixtures	410	
Outlet, Switch and Junction Boxes, Fittings		370-4
		370-15
Panelboards		384-27
Receptacles and Attachment Plugs		410-58
Services	230	
Service Equipment		230-63
Swimming Pools, Fountains and Similar Installations	680	
Switches		380-1
		380-12

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.

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

(3) Where the system is nominally rated 240/120-volt, 3-phase, 4-wire in which the midpoint of one phase is used as a circuit conductor.

(4) Where a service conductor is uninsulated in accordance with Section 230-4.

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, lightning 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 Connections for Alternating-Current Systems.

(a) An AC system that is grounded on the premises shall have a grounding electrode conductor connected to a grounding electrode at each service. Such supply systems that originate outside the building shall have at least one additional grounding connection made to a grounding electrode on the secondary side of the transformer supplying the system, either at the transformer or elsewhere. The grounding electrode conductor shall be connected to the AC system on the supply side of the service disconnecting means at an accessible point on the load side of the service drop or service lateral, preferably within the enclosure for the service disconnecting means. Grounding connections shall not be made on the load side of the service disconnecting means.

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 1000 volts or less is grounded at any point, the grounded conductor shall be run to each service. 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 phase conductors larger than 1100 MCM, the grounded conductor shall not be smaller than 12½ percent of the area of the largest phase conductor.

Exception: The grounded conductor shall not be required to be larger than the largest ungrounded service conductor.

250-24. Two or More Buildings Supplied from Single Service Equipment.

(a) Grounded Systems: Where two or more buildings are supplied by a grounded system from a single service equipment, each building shall have a grounding electrode connected to the AC system grounded circuit conductor on the supply side of the building disconnecting means.

(b) Ungrounded Systems: Where two or more buildings are supplied by an ungrounded system from a single service equipment, each building shall have a grounding electrode connected to the metal enclosure of the building disconnecting means.

Exception for (a) and (b) above: A grounding electrode at a separate building shall not be required where the conditions of either a. or b. below are met:

a. Only one branch circuit is supplied and there is no equipment in the building that requires grounding.

b. No livestock is housed in the building, an equipment grounding conductor is run with the circuit conductors for grounding any noncurrent-carrying equipment, interior metal piping systems or building metal frames and the equipment grounding conductor is bonded to grounding electrodes described in Sections 250-81 and 250-83 which exist at the building.

250-25. Conductor to Be Grounded — Alternating-Current Systems. For AC premises wiring systems, the conductor to be grounded shall be as specified in (a) through (e) below.

(a) Single-phase, 2-wire: the identified conductor.

(b) Single-phase, 3-wire: the identified neutral conductor.

(c) Multiphase systems having one wire common to all phases: the identified common conductor.

(d) Multiphase systems having one phase grounded: the identified conductor.

(e) Multiphase systems in which one phase is used as in (b) above: the identified neutral conductor.

See Article 200 for means of identification.

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, if in runs of less than 25 feet, 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: Metal enclosures used to protect cable assemblies from physical damage 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) Where within 8 feet vertically or 5 feet horizontally of ground or grounded metal objects and subject to contact by persons.

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

(c) Where in electrical contact with metal.

(e) Where supplied by a metal-clad, metal-sheathed, or metal-raceway wiring method, except as permitted by Section 250-33 for short sections of raceway.

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

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

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

(i) Equipment supplied by Class 1, Class 2, and Class 3 remote-control and signaling circuits where required to be grounded by Part B of this article.

250-44. Nonelectric Equipment.

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 (b) and (c) below, exposed noncurrent-carrying metal parts of cord- and plug-connected equipment likely to become energized shall be grounded.

(b) Where operated at over 150 volts to ground.

Exception No. 1: Motors, where guarded.

Exception No. 2: Metal frames of electrically heated appliances exempted by Section 422-16.

(c) In residential occupancies: (1) refrigerators, freezers, and air conditioners; (2) clothes-washing, clothes-drying, dish-washing machines, sump pumps, and 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 on the supply side of the service disconnecting means and 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 circuit conductor and the grounding electrode conductor.

Exception: 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 grounded cold water pipe near the equipment.

250-51. Effective Grounding Path. The path to ground from circuits, equipment, and conductor enclosures shall:

(a) Be permanent and continuous.

(b) Have capacity to conduct safely any fault current likely to be imposed on it.

(c) Have sufficiently low impedance to limit the voltage to ground and to facilitate the operation of the circuit protective devices in the circuit.

250-53. Grounding Path to Grounding Electrode.

(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 conductor to the grounding electrode.

(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. A main bonding jumper shall be a wire, bus, screw, or similar suitable conductor.

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.

Two or more electrodes that are effectively bonded together shall be considered as a single electrode 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, where required to be grounded, shall be grounded by one of the methods indicated in (a), (b), or (c) below.

(a) By any of the equipment grounding conductors permitted by Section 250-91(b).

(b) 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 grounding conductors shall have a contin-

uous outer finish that is either green, or green with one or more yellow stripes.

Exception No. 1: An insulated 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:

a. Stripping the insulation from the entire exposed length,

b. Coloring the exposed insulation green, or

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

Exception No. 2: For direct-current circuits only, the equipment grounding conductor shall be permitted to be run separately from the circuit conductors.

(c) By special permission, other means for grounding fixed equipment may be used.

See Section 400-7 for use of cords for fixed equipment.

250-58. Equipment Considered Effectively Grounded. Under the conditions specified in (a) 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 of the conductors supplying such equipment if 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 connectors approved for the purpose.

(b) By means of a 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 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) By means of a separate flexible wire or strap, insulated or bare, protected as well as practicable against physical damage, where part of equipment, or by special permission.

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 or travel trailers 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 120/208-volt derived from a 3-phase, 4-wire, wye-connected system.

(b) The grounded conductor is not smaller than No. 10.

(c) The grounded conductor is insulated; or the grounded conductor is uninsulated and part of a 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 on the supply side of the service disconnecting means, such as meter enclosures, service raceways, etc., and on the supply side of the main disconnecting means of separate buildings and of separately derived systems as provided in Sections 250-24 and 250-26 (in the NEC) respectively.

(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.

Exception No. 4: By special permission in Section 250-57(c).

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

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

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

(c) Any conduit or armor enclosing a grounding electrode conductor.

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) Bonding equipment to the grounded service conductor in a manner provided in Section 250-113.

(b) 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 made up tight for rigid metal conduit, intermediate metal conduit and electrical metallic tubing.

(d) Bonding jumpers meeting the other requirements of this article. Bonding jumpers 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, such as bonding-type locknuts and bushings, approved for the purpose.

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.

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 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.

(b) 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.

(c) 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. Where the service-entrance phase conductors are larger than 1100 MCM copper or 1750 MCM aluminum, the bonding jumper shall have an area not less than 12½ percent of the area of the largest phase conductor except that where the phase conductors and the bonding jumper are of different materials (copper or aluminum), the minimum size of the bonding jumper shall be based on the assumed use of phase conductors of the same material as the bonding jumper and with an ampacity equivalent to that of the installed phase conductors. Where the service-entrance conductors are paralleled in two or more raceways, the size of the bonding jumper for each raceway shall be based on the size of service conductors in each raceway.

(d) 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.

(e) 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 six feet and shall be routed with the raceway or enclosure.

250-80. Bonding of Piping Systems.

(a) Metal Water Piping. The interior metal water piping system shall always 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.

(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.

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 shall be bonded together to form the grounding electrode system. The bonding jumper shall be sized in accordance with Section 250-79(c) and shall be connected in the manner specified in Section 250-115.

(a) A metal underground water pipe in direct contact with the earth for 10 feet 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.

(b) The metal frame of the building, where effectively grounded.

(c) An electrode encased by at least 2 inches 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 of one or more steel reinforcing bars or rods of not less than ½ inch diameter, or consisting of at least 20 feet of bare solid copper conductor not smaller than No. 4 AWG.

(d) A ground ring encircling the building or structure, in direct contact with the earth at a depth below earth surface not less than 2½ feet, consisting of at least 20 feet 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 (a) 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 system is used (including those used for lightning rods), each electrode of one system shall not be less than 6 feet from any other electrode of another system.

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

(a) An electrically continuous metal underground gas piping system that is uninterrupted with insulating sections or joints and without an outer nonconductive coating, and then only if acceptable to and expressly permitted by both the serving gas supplier and the authority having jurisdiction.

(b) 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 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 ¾-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 steel or iron shall be at least ⅝ inch in diameter. Nonferrous rods or their equivalent shall be listed and shall be not less than ½ inch in diameter.

(3) Where rock bottom is not encountered, the electrode shall be driven to a depth of 8 feet. Where rock bottom is encountered at a depth of less than 4 feet, electrodes not less than 8 feet long shall be buried in a trench.

(d) Plate Electrodes. Each plate electrode shall expose not less than 2 square feet of surface to exterior soil. Electrodes of iron or steel plates shall

be at least ¼ inch in thickness. Electrodes of nonferrous metal shall be at least 0.06 inch in thickness.

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 Sections 250-81 or 250-83 for grounding wiring systems and equipment. This provision shall not prohibit the required bonding together of grounding electrodes of different systems.

See Sections 250-46, 800-31(b)(7), and 820-22(h) in the NEC.

Bonding together of all separate grounding electrode systems 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) and (b) 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. 1: Splices in busbars shall be permitted.

Exception No. 2: Where a service consists of more than a single enclosure as permitted in Section 230-45, 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 Table 250-94, but the tap conductors shall be permitted to be sized in accordance with the grounding electrode conductors specified in Table 250-94 for the largest conductor serving the respective enclosures.

(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 approved for the purpose and installed with fittings approved for the purpose; (6) armor of Type AC cable; (10) other raceways specifically approved for grounding purposes.

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

a. The total length in any ground return path does not exceed 6 feet.

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 approved for the purpose.

Exception No. 2: Liquidtight flexible metal conduit shall be permitted for grounding in the 1¼-inch and smaller trade sizes if the total length in any ground return path does not exceed 6 feet and the conduit is terminated in fittings approved for the purpose.

(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) and (b) 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 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 rigidly stapled to the construction; otherwise, it shall be in rigid metal conduit, intermediate metal conduit, electrical metallic tubing, or cable armor. Grounding conductors smaller than No. 6 shall be in rigid metal conduit, intermediate metal conduit, electrical metallic tubing, or cable armor.

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 intermediate metal conduit is used for protection for a grounding conductor, the installation shall comply with the requirements of Article 345. Where rigid metal conduit is used as protection for a grounding conductor, the installation shall comply with the requirements of Article 346. Where electrical metallic tubing is used, the installation shall comply with the requirements of Article 348.

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 of the earth.

(b) 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 grounding conductor as provided in Section 210-7 or by special permission as provided in Section 250-57(c), 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. Where connected to made electrodes (as in Section 250-83), that portion of the grounding electrode conductor which is the sole connection between the grounding electrode and the grounded system conductor shall not be required to be larger than No. 6 copper wire or its equivalent in ampacity.

Table 250-94

Grounding Electrode Conductor for AC Systems

Size of Largest Service-Entrance Conductor or Equivalent for Parallel Conductors		Size of Grounding Electrode Conductor	
Copper	Aluminum or Copper-Clad Aluminum	Copper	*Aluminum or Copper-Clad Aluminum
2 or smaller	0 or smaller	8	6
1 or 0	2/0 or 3/0	6	4
2/0 or 3/0	4/0 or 250 MCM	4	2

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 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.

Where conductors are run in parallel in multiple raceways, as permitted in Section 310-4 in the NEC, the equipment grounding conductor, where used, shall be run in parallel. Each parallel equipment grounding conductor shall be sized on the basis of the ampere rating of the overcurrent device protecting the circuit conductors in the raceway in accordance with Table 250-95.

When conductors are adjusted in size to compensate for voltage drop, grounding conductors, where required, shall be adjusted proportionately in size.

Exception No. 1: An equipment grounding conductor not smaller than No. 18 copper and not smaller than the circuit conductors if an integral part of a listed flexible cord assembly shall be permitted for grounding cord-connected equipment where the equipment is protected by overcurrent devices not exceeding 20-ampere rating.

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 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).

250-98. Grounding Conductor in Common Raceway. A grounding conductor shall be permitted in the same raceway or enclosure with other conductors of the system to which it is connected.

250-99. Grounding Conductor Continuity.

(a) Separable Connections. Separable connections such as those provided in draw-out equipment or 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 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

250-111. To Raceway or Cable Armor. The point of connection of the grounding conductor to interior metal raceways, cable armor, and the like shall be as near as practicable to the source of supply and shall be so chosen that no raceway or cable armor is grounded through a run of smaller size than is called for in Section 250-95.

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.

Exception: A connection to a concrete encased, driven, or buried grounding electrode shall not be required to be accessible.

250-113. To Conductors and Equipment. Required grounding conductors and bonding jumpers shall be connected by pressure connectors, clamps, or other approved means. Connection devices or fittings that depend 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 of a branch circuit enters a box, all such conductors shall be in good electrical contact with each other and the arrangement shall be such that the disconnection or 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 an approved 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 suitable lugs, pressure connectors, clamps, or other approved means. Connections depending on solder shall not be used. Ground clamps shall be suitable for the materials of the grounding electrode and the grounding electrode conductor. Not more than one conductor shall be connected to the grounding electrode by a single clamp or fitting unless the clamp or fitting is approved for the use. One of the methods indicated in (a), (b), (c), or (d) below shall be used.

(a) An approved bolted clamp of cast bronze or brass or plain or malleable iron.

(b) A pipe fitting, pipe plug, or other approved device screwed into a pipe or pipe fitting.

(c) A 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) 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) Installations where they are not likely to be damaged.

(b) 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.

ARTICLE 280 — LIGHTNING ARRESTERS

Installations shall conform to the requirements of Article 280 of the 1978 National Electrical Code (NFPA No. 70-1978).

ARTICLE 300 — WIRING METHODS

A. General Requirements

300-1. Scope.

(a) The provisions of this article shall apply to all wiring installations.

Exception No. 1: Only those sections referenced in Article 725 shall apply to Class 1, Class 2, and Class 3 circuits.

Exception No. 2: Only those sections referenced in Article 760 shall apply to fire protective signaling circuits.

Exception No. 3: Only those sections referenced in Article 800 in the NEC shall apply to communication systems.

(b) 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. Voltage Limitations. Wiring methods specified in Chapter 3 of the NEC shall be used for voltages not exceeding 600 where not specifically limited in some section of Chapter 3. They shall be permitted for voltages over 600 where specifically permitted elsewhere in this Code.

300-3. Conductors of Different Systems.

(a) Conductors of 600 volts or less shall be permitted to occupy the same equipment wiring enclosure, cable, or raceway, without regard to whether the individual circuits are alternating current or direct current, where all conductors are insulated for the maximum voltage of any conductor within the enclosure, cable, or raceway.

(b) Conductors of over 600 volts shall not occupy the same equipment wiring enclosure, cable, or raceway with conductors of 600 volts or less.

Exception No. 1: Secondary wiring to electric-discharge lamps of 1000 volts or less, if insulated for the secondary voltage involved, shall be permitted to occupy the same fixture enclosure as the branch-circuit conductors.

Exception No. 2: Primary leads of electric-discharge lamp ballasts, insulated for the primary voltage of the ballast, when contained within the individual wiring enclosure, shall be permitted to occupy the same fixture enclosure as the branch-circuit conductors.

Exception No. 3: Excitation, control, relay, and ammeter conductors used in connection with any individual motor or starter shall be permitted to occupy the same enclosure as the motor circuit conductors.

300-4. Protection Against Physical Damage. Where subject to physical damage, conductors shall be adequately protected.

(a) Cables Through Wood Framing 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 similar structural wood members, holes shall be bored at the approximate center of the face of the member. Holes in studs for cable-type wiring methods shall be bored so that the edge of the hole is not less than 1¼ inches from the nearest edge of the stud or shall be protected from nails and screws by either a steel plate or bushing at least 1/16 inch thick and of appropriate length and width installed to cover the area through which nails or screws might penetrate the installed cable.

(2) Notches in Wood. Where there is no objection because of weakening the building structure, in both exposed and concealed locations, cables shall be permitted to be laid in notches in wood studs, joists, rafters or other wood members where the cable at those points is protected against nails or screws by a steel plate at least 1/16 inch thick installed before the building finish is applied.

(b) Cables Through Metal Framing Members. 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 approved for the purpose securely fastened in the opening. Where nails or screws are likely to penetrate the cable, a steel sleeve, steel plate or steel clip not less than 1/16 inch in wall thickness shall be used to protect the nonmetallic cable.

Exception: When the slots or holes are so formed that no metal edge can cut or tear cable insulation, bushings or grommets shall not be required.

300-5. Underground Installations.

(a) Minimum Cover Requirements. Direct buried cable or conduit or other raceways approved for the purpose shall be installed to meet the minimum cover requirements of Table 300-5.

Exception No. 1: The minimum cover requirements shall be permitted to be reduced by 6 inches for installations where a 2-inch thick concrete pad or equivalent in physical protection is placed in the trench over the underground installation.

Exception No. 2: The minimum cover requirements shall not apply to conduits or other raceways which are located under a building or exterior concrete slab not less than 4 inches in thickness and extending not less than 6 inches beyond the underground installation.

Exception No. 4: Residential branch circuits rated 300 volts or less and provided with overcurrent protection of not more than 30 amperes shall be permitted with a cover requirement of 12 inches.

Exception No. 5: Lesser depths are permitted where cables and conductors rise for terminations or splices or where access is otherwise required.

Exception No. 7: Raceways installed in solid rock shall be permitted to be buried at a lesser depth when covered by 2 inches or more of concrete over the installation and extending down to the rock surface.

Exception No. 8: Circuits for the control of irrigation and landscape lighting systems which are limited to not more than 30 volts and are installed with Type UF or other approved cable shall be permitted with a minimum cover of 6 inches.

Table 300-5

Minimum Cover Requirements, 0 to 600 Volts

(Cover is defined as the distance between the top surface of direct buried cable, conduit, or other raceways approved for the purpose and the finished grade.)

Wiring Method	Minimum Burial (Inches)
Direct Buried Cables	24
Rigid Metal Conduit	6
Intermediate Metal Conduit	6
Rigid Nonmetallic Conduit Approved for Direct Burial without Concrete Encasement	18
Other Approved Raceways*	18

* Note: Raceways approved for burial only when concrete encased shall require a concrete envelope not less than 2 inches thick.

(b) Grounding. Metallic shielding, sheath, or metallic conduit shall be effectively grounded at terminations and meet the requirements of Section 250-51.

(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. Conductors emerging from the ground shall be enclosed in enclosures or raceways approved for the purpose. Raceways installed on poles shall be of rigid metal conduit, intermediate metal conduit, PVC Schedule 80, or equivalent. The enclosures or raceways shall extend from below the ground line up to a point eight feet above finished grade. Conductors entering a building shall be protected by an approved entrance or raceway from below the ground line to the point of entrance.

(e) Splices and Taps. Underground cables in trenches shall be permitted to be spliced or tapped without the use of splice boxes. The splices or taps shall be made by methods and with material approved for the purpose.

(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.

(h) Bushing. A bushing shall be used at the end of a conduit which terminates underground where cables leave the conduit 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 including the grounding conductor where required 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) 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.

(b) 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, except as provided for nonmetallic boxes in Section 370-7(c).

300-11. Secured in Place. Raceways, cable assemblies, boxes, cabinets, and fittings shall be securely fastened in place, unless otherwise provided for specific purposes elsewhere in this Code.

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.

300-13. Mechanical and Electrical Continuity — Conductors.

(a) Conductors 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 in the NEC for metal surface raceways.

(b) In multiwire circuits the continuity of an identified 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 and Switch Points. At least 6 inches of free conductor shall be left at each outlet and switch point for splices or the connection of fixtures or devices.

Exception: Conductors that are not spliced or terminated at the outlet 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, multi-outlet assemblies, and auxiliary gutters, cable trays and conduit bodies having removable covers which are accessible after installation.

Exception No. 2: As permitted in Section 410-31 where a fixture approved for the purpose 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: As permitted by Section 336-11 for insulated outlet devices supplied by nonmetallic-sheathed cable.

Exception No. 4: Where cables enter or exit from conduit or tubing which is used to provide cable support or protection against physical damage.

Exception No. 5: Wiring devices with integral enclosures approved for the purpose, having brackets that securely fasten the device in walls or ceilings of frame construction for use with nonmetallic-sheathed cable, shall be permitted without a separate box.

See Sections 336-5, Exception No. 2; 336-11; and 545-10 in the NEC.

300-16. Raceway or Cable to Open or Concealed Wiring.

(a) A box or terminal fitting having a separately bushed hole for each conductor shall be used wherever a change is made from conduit, electrical metallic tubing, nonmetallic-sheathed cable, Type AC cable, Type MC

cable, or mineral-insulated metal-sheathed cable and surface raceway wiring to open wiring or to concealed knob-and-tube wiring. A fitting used for this purpose shall contain no taps or splices and shall not be used at fixture outlets.

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.

See the following sections of this Code: conduit, Sections 345-7 and 346-6; electrical metallic tubing, 348-6; flexible metallic tubing, 349-12; flexible metal conduit, 350-3; liquidtight flexible metal conduit, 351-6; Class 1, Class 2, and Class 3 circuits, Article 725; and fire protective signaling circuits, Article 760.

300-18. Inserting Conductors in Raceways.

(a) Raceways shall first be installed as a complete raceway system without conductors.

Exception: Exposed raceways having a removable cover or capping.

(b) Where possible, conductors shall not be inserted until the interior of the building has been physically protected from the weather, and all mechanical work on the building which is likely to injure the conductors has been completed.

(c) Pull wires, if to be used, shall not be installed until the raceway system is in place.

(d) Cleaning agents or materials used as lubricants that might have a deleterious effect on conductor coverings shall not be used.

300-20. Induced Currents in Metal Enclosures or Metal Raceways. 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: As permitted in Section 250-50, Exception for equipment grounding connections.

When a single conductor of a circuit 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.

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. Prevention of Fire Spread. Electrical installations shall be so made that the possible spread of fire or products of combustion through fire-rated, fire-resistant or fire-stopped walls, partitions, ceilings and floors; hollow spaces; vertical shafts; and ventilating or air-handling ducts will not be substantially increased.

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.

See Article 424, Part F for Electric Duct Heaters.

(b) Ducts or Plenums Used for Environmental Air. Only wiring methods consisting of mineral-insulated metal-sheathed cable, Type MC cable employing a smooth or corrugated impervious metal sheath, electrical metallic tubing, flexible metallic tubing, intermediate metal conduit, or rigid metal conduit shall be installed in ducts or plenums used for environmental air. Flexible metal conduit, flexible metallic tubing and liquidtight flexible metal conduit shall be permitted, in lengths not to exceed 4 feet, 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. Only mineral-insulated metal-sheathed cable, Type MC cable, and Type AC cable shall be used for wiring in systems installed in other space used for environmental air. Other type cables and conductors shall be installed in electrical metallic tubing, intermediate metal conduit, rigid metal conduit, metal surface raceway with metal covers where accessible, or flexible metal conduit. Electric equipment that is permitted within a building concealed space shall be permitted to be installed in other space used for environmental air if the associated wiring material and fixtures are suitable for the ambient temperature.

Exception No. 1: Liquidtight flexible metal conduit and flexible metallic tubing in single lengths not exceeding 6 feet.

Exception No. 2: The above provisions shall not apply to integral fan systems specifically approved for the purpose.

Exception No. 3: This section does not include habitable rooms or areas of buildings, the prime purpose of which is not air handling.

ARTICLE 305 — TEMPORARY WIRING

A. 600 Volts, Nominal or Less

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. Except as specifically modified in this article, all other requirements of this Code for permanent wiring shall apply to temporary wiring installations.

(a) 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) Temporary electrical power and lighting installations shall be permitted for a period not to exceed 90 days for Christmas decorative lighting, carnivals, and similar purposes, and for experimental or development work.

305-2. 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. The conductors shall be permitted within multiconductor cord or cable assemblies or where not subject to mechanical injury, they shall be permitted to be run as open conductors on insulators not more than 10 feet apart.

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

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

See Section 210-8 for receptacles installed on construction sites.

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

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

(g) Lamp Protection. All lamps for general illumination shall be protected from accidental contact or breakage. Protection shall be provided

by elevation of at least 7 feet from normal working surface or by a suitable fixture or lampholder with a guard.

(h) Splices. On construction sites a box shall not be required for splices or junction connections where the circuit conductors are multi-conductor cord or cable assemblies or open conductors. See Sections 110-14(b) and 400-9. A box shall be used wherever a change is made to a raceway system or a cable system which is metal clad or metal sheathed.

(i) 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.

305-3. Grounding. All grounding shall conform with Article 250.

ARTICLE 310 — CONDUCTORS FOR GENERAL WIRING

A. General

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.

For flexible cords and cables, see Article 400. For fixture wires, see Article 402 in the NEC.

310-2. Conductors to Be Insulated. Conductors shall be insulated.

Exception: Where covered or bare conductors are specifically permitted elsewhere in this Code.

See Section 250-152 in the NEC for insulation of neutral conductors of a solidly grounded high-voltage system.

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 410-23 in the NEC.

Exception No. 6: For Class 1, Class 2 and Class 3 circuits as permitted by Sections 725-16, 725-37, and 725-40.

Exception No. 7: For fire protective signaling circuits as permitted by Sections 760-16, 760-27, and 760-30.

310-6. Underground Conductors. Cables of one or more conductors for direct burial in the earth or in underground raceways shall be of a type approved for the purpose and use.

Where necessary to prevent physical damage to the conductors from rocks, slate, or similar materials, or from vehicular or similar traffic, direct buried conductors shall be provided with supplementary protection, such as sand, sand and suitable running boards, suitable sleeves, or other approved means.

See Section 339-3 for Type UF cable.

310-7. Wet Locations.

(a) Insulated Conductors. Insulated conductors used in wet locations shall be (1) lead-covered; (2) Types RHW, RUW, TW, THW, THWN, XHHW; or (3) of a type approved for the purpose.

(b) Cables. Cables of one or more conductors used in wet locations shall be of a type approved for the purpose and use.

Such conductors shall not be used for direct burial in the earth unless of a type approved for the purpose.

310-9. 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.

310-10. 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.

For identification requirements for conductors larger than No. 6, see Section 200-6.

(b) Grounding Conductors. Bare, covered or insulated equipment 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 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 from the entire exposed length;

b. Coloring the exposed insulation green; or

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

(c) Ungrounded Conductor. 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).

310-11. 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 working voltage for which the conductor was tested or approved.

(2) The proper type letter or letters for the type of wire or cable as specified elsewhere in this article, in Tables 310-13 and 310-31 in the NEC, and in Articles 336, 338, 339 and 725-40(b)(4).

(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 at intervals not exceeding 24 inches:

(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.

Included in the group of metal-covered cables are: Type AC cable (Article 333) and lead-sheathed cable.

(3) Tag Marking. The following conductors and cables shall be marked by means of a printed tag attached to the coil, reel, or carton:

(c) Metal-covered single-conductor cables.

(e) Type AC cable.

310-15. Ampacity. The maximum continuous ampacities for copper, aluminum, and copper-clad aluminum conductors shall be as specified in Table 310-16 and accompanying Notes 1, 3, 8, and 11.

Notes to Table 310-16

1. Explanation of Table. For explanation of Type Letters, and for recognized size of conductors for the various conductor insulations, see Sections 310-12 and 310-13 in the NEC. For installation requirements, see Sections 310-1 through 310-9, and the various articles of this Code. For flexible cords see Tables 400-4 and 400-5 in the NEC.

3. Three-Wire, Single-Phase Residential Service. In a residential occupancy conductors, as listed below, shall be permitted to be utilized as three-wire, single-phase, service-entrance conductors and the three-wire, single-phase feeder that carries the total current supplied by that service.

8. More Than 3 Conductors in a Raceway or Cable. Where the number of conductors in a raceway or cable exceed 3, the maximum allowable load current of each conductor shall be reduced as shown in the following table:

Number of Conductors	Percent of Values in Tables 310-16 and 310-18
4 thru 6	80
7 thru 24	70
25 thru 42	60
43 and above	50

Conductor Types and Sizes RH-RHH-RHW-THW-THWN-THHN-XHHW

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

Where single conductors or multiconductor cables are stacked or bundled without maintaining spacing and are not installed in raceways, the maximum allowable load current of each conductor shall be reduced as shown in the above table.

Exception No. 1: When conductors of different systems, as provided in Section 300-3, are installed in a common raceway the derating factors shown above shall apply to the number of power and lighting (Articles 210, 215, 220, and 230) conductors only.

Exception No. 2: The derating factors of Sections 210-22(c), 220-2(a) and 220-10(b) in the NEC shall not apply when the above derating factors are also required.

11. Grounding Conductor. A grounding conductor shall not be counted in determining ampacities as provided for in Note 8.

Table 310-16. Allowable Ampacities of Insulated Conductors Rated 0-2000 Volts, 60° to 90°C

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 MCM	TYPES RUW, T, TW, UF	TYPES FEPW, RH, RHW, RUH, THW, THWN, XHHW, USE, ZW	TYPES V, MI	TYPES TA, TBS, SA, AVB, SIS, †FEP, †FEPB, †RHH, †THHN, †XHHW*	TYPES RUW, T, TW, UF	TYPES RH, RHW, RUH, THW, THWN, XHHW, USE	TYPES V, MI	TYPES TA, TBS, SA, AVB, SIS, †RHH, †THHN, †XHHW*	AWG MCM
	COPPER				ALUMINUM OR COPPER-CLAD ALUMINUM				
18	....	....	....	21	....	....	....	....	....
16	....	....	22	22	....	....	....	....	....
14	15	15	25	25	....	....	....	....	....
12	20	20	30	30	15	15	25	25	12
10	30	30	40	40	25	25	30	30	10
8	40	45	50	50	30	40	40	40	8
6	55	65	70	70	40	50	55	55	6
4	70	85	90	90	55	65	70	70	4
3	80	100	105	105	65	75	80	80	3
2	95	115	120	120	75	90	95	95	2
1	110	130	140	140	85	100	110	110	1
0	125	150	155	155	100	120	125	125	0
00	145	175	185	185	115	135	145	145	00
000	165	200	210	210	130	155	165	165	000
0000	195	230	235	235	155	180	185	185	0000
	CORRECTION FACTORS								
Ambient Temp. °C	For ambient temperatures over 30°C, multiply the ampacities shown above by the appropriate correction factor to determine the maximum allowable load current.								Ambient Temp. °F
31-40	.82	.88	.90	.91	.82	.88	.90	.91	86-104
41-50	.58	.75	.80	.82	.58	.75	.80	.82	105-122
51-60	....	.58	.67	.71	....	.58	.67	.71	123-141
61-70	....	.35	.52	.58	....	.35	.52	.58	142-158
71-80	....	....	.30	.41	....	....	.30	.41	159-176

† The load current rating and the overcurrent protection for these conductors 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.

* For dry locations only. See 75°C column for wet locations.

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.

333-4. Construction. Type AC cable shall be an approved cable with acceptable metal covering. The insulated conductors shall conform with Section 333-5.

Type AC cables are branch-circuit and feeder cables with armor of flexible metal tape. 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 in the NEC. 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.

333-6. Use. 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 and 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.

Type ACL cable shall not be used for direct burial in the earth.

333-7. Supports. Type AC cable shall be secured by approved staples, straps, hangers or similar fittings so designed and installed as not to injure the cable at intervals not exceeding 4½ feet and within 12 inches from every outlet box or fitting.

Exception No. 1: Where cable is fished.

Exception No. 2: Lengths of not more than 2 feet at terminals where flexibility is necessary.

333-8. Bends. All bends shall be made so that the cable will not be injured, and the radius of the curve of the inner edge of any bend shall not be less than 5 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 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 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.

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, or within 7 feet 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 of the nearest edge of the scuttle hole or attic entrance.

(b) Where cable is carried along the sides of rafters, studs or floor joists, neither guard strips nor running boards shall be required.

ARTICLE 336 — NONMETALLIC-SHEATHED CABLE

Types NM and NMC

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. Construction. Nonmetallic-sheathed cable shall be an approved Type NM or NMC in sizes No. 14 through 2 with copper conductors and in sizes No. 12 through 2 with aluminum or copper-clad aluminum conductors. In addition to the insulated conductors, the cable may have an approved size of insulated or bare conductor for equipment grounding purposes only.

Conductors of Types NM and NMC shall be one of the types listed in Table 310-13 in the NEC which is suitable for branch-circuit wiring or one which is approved for the purpose. The ampacity of Types NM and NMC cable shall be that of 60°C (140°F) conductors in Table 310-16.

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

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

(c) 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.

336-3. Uses Permitted or Not Permitted. Type NM and Type NMC cables shall be permitted to be used in one- and two-family dwellings, or multifamily dwellings and other structures not exceeding three floors above grade. For the purpose of this article, the first floor of a building shall be that floor designed for human habitation which is level with or above finished grade of the exterior wall line of 50 percent or more of its perimeter.

(a) Type NM. This type of nonmetallic-sheathed cable shall be permitted to be installed 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.

Type NM cable shall not be installed where exposed to corrosive fumes or vapors; nor shall it be imbedded in masonry, concrete, adobe, fill, or plaster; nor run in a shallow chase in masonry, concrete or adobe and covered with plaster, adobe or similar finish.

(b) Type NMC. Type NMC cable shall be permitted for both exposed and concealed work in dry, moist, damp, or corrosive locations, and in outside and inside walls of masonry block or tile.

(c) Uses Not Permitted for Either Type NM or NMC. Types NM and NMC cables shall not be used as: (1) service-entrance cable, (8) embedded in poured cement, concrete, or aggregate.

336-4. 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 Article 300.

336-5. Supports. Nonmetallic-sheathed cable shall be secured by staples, straps, or similar fittings so designed and installed as not to injure the cable. Cable shall be secured in place at intervals not exceeding 4½ feet and within 12 inches 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 approved for the purpose, 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 and within 12 inches from the wiring device wall opening, and there shall be at least a 12-inch loop of unbroken cable or 6 inches of a cable end available on the interior side of the finished wall to permit replacement.

336-6. Exposed Work — General. In exposed work, except as provided in Sections 336-8 and 336-9, 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, pipe, guard strips, or other means. Where passing through a floor the cable shall be enclosed in rigid metal conduit, intermediate metal conduit or metal pipe extending at least 6 inches above the floor.

336-7. Through Studs, Joists, and Rafters. The cable shall comply with Section 300-4 where installed through studs, joists, rafters, and similar members.

336-8. 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.

336-9. In Accessible Attics. The installation of cable in accessible attics or roof spaces shall also comply with Section 333-12.

336-10. Bends. Bends in cable shall be so made, and other handling shall be such, that the protective coverings of the cable will not be injured, and no bend shall have a radius less than 5 times the diameter of the cable.

336-11. 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 approved for multiconductors.

336-12. Boxes of Insulating Material. Nonmetallic outlet boxes shall be permitted as provided in Section 370-3 in the NEC.

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

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

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.

See Section 230-40, Exception 2.

(c) 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.

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. Installation Methods.

(a) In addition to the provisions of this article, Type SE service-entrance

cable used for interior wiring shall comply with the applicable provisions of Article 300.

(b) Unarmored cable shall be installed in accordance with the applicable provisions of Article 336.

(c) Cables shall comply with Section 300-4 where installed through studs, joists, rafters, or similar members.

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 through No. 4/0. The conductors of Type UF shall be one of the moisture-resistant types listed in Table 310-13 of the NEC which is suitable for branch-circuit wiring or one which is approved for the purpose. The ampacity of Type UF cable shall be that of 60°C (140°F) conductors in Table 310-16. 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-resistant, fungus-resistant, 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, sub-feeder circuit, or branch circuit, including the neutral 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 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.

Type UF cable supported by cable trays shall be of the multiconductor type.

(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 approved for the purpose.

339-4. Overcurrent Protection. Overcurrent protection shall be provided in accordance with provisions of Section 240-3.

339-5. Rated Ampacity. The ampacities of conductors in Type UF cable shall be according to 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) 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.

See Section 250-91.

Exception: Aluminum fittings and enclosures shall be permitted to be used with steel intermediate metal conduit.

(b) 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.

See Section 300-6.

(c) 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 two inches thick; when the conduit is not less than 18 inches under the fill; or when protected by corrosion protection and judged suitable for the condition.

See Section 300-6.

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 approved for the purpose.

See Section 300-6 for protection against corrosion.

345-6. Size.

(a) Minimum. Conduit smaller than ½-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, Tables and Examples, using the conduit dimensions of Table 4, Tables and Examples.

345-8. Reaming and Threading. All cut ends of conduit shall be reamed to remove rough edges. Where conduit is threaded in the field, an electrical conduit thread cutting die with a taper shall be used.

345-9. Couplings and Connectors.

(a) Threadless couplings and connectors used with conduit shall be made tight. Where buried in masonry or concrete, they shall be the concrete-tight type. Where installed in wet locations, they shall be the raintight type.

(b) 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 injured, 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 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. A run of conduit between outlet and outlet, between fitting and fitting, or between outlet and fitting, shall not contain more than the equivalent of 4 quarter bends (360 degrees, total), including those bends located immediately at the outlet or fitting.

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 three feet of each outlet box, junction box, cabinet, or fitting. Conduit shall be supported at least every ten feet.

345-13. Boxes and Fittings. See Article 370.

345-14. Splices and Taps. Splices and taps shall be made only in junction, outlet boxes or conduit bodies. Conductors, including splices and taps, shall not fill a conduit body to more than 75 percent of its cross-sectional area at any point. All splices and taps shall be made by approved methods.

345-15. Bushings. Where a conduit enters a box or fitting, a bushing shall be provided to protect the wire from abrasion unless the design of the box or fitting is such as to afford equivalent protection. See Section 373-6(c) for the protection of conductors 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) 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) Where practicable, dissimilar metals in contact anywhere in the system shall be avoided to eliminate the possibility of galvanic action.

(c) 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.

See Section 300-6.

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 thick.

Exception No. 3: Where the conduit is at least 18 inches 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 approved for the purpose.

See Section 300-6 for protection against corrosion.

346-5. Minimum Size. Conduit smaller than ½ 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.

346-7. Reaming and Threading.

(a) All cut ends of conduits shall be reamed to remove rough edges.

(b) Where conduit is threaded in the field, a standard conduit cutting die with a ¾ inch taper per foot shall be used.

346-8. Bushings. Where a conduit enters a box or other fitting, a

bushing shall be provided to protect the wire from abrasion unless the design of the box or fitting is such as to afford equivalent protection.

See Section 373-6(c) for the protection of conductors at bushings.

346-9. Couplings and Connectors.

(a) Threadless couplings and connectors used with conduit shall be made tight. Where buried in masonry or concrete, they shall be of the concrete-tight type. Where installed in wet locations, they shall be of the raintight type.

(b) 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 injured, 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
2½	15	25
3	18	31
3½	21	36
4	24	40
4½	27	45
5	30	50
6	36	61

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.

346-11. Bends — Number in One Run. A run of conduit between outlet and outlet, fitting and fitting, or outlet and fitting shall not contain more than the equivalent of four quarter bends (360 degrees, total), including those bends located immediately at the outlet or fitting.

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 of each outlet box, junction box, cabinet, or fitting. Conduit shall be supported at least every 10 feet.

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 346-10. 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
2½	10½
3	13
3½	15
4	16
4½	20
5	24
6	30

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
3 and larger	20

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, outlet boxes or conduit bodies. Conductors, including splices and taps, shall not fill a conduit body to more than 75 percent of its cross-sectional area at any point. All splices and taps shall be made by approved methods.

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 thick or unless the tubing is at least 18 inches 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.

See Section 300-6.

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 metals approved for the purpose.

See Section 300-6 for protection from corrosion.

348-5. Size.

(a) Minimum. Tubing smaller than ½-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, 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 concrete-tight 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 injured 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. A run of electrical metallic tubing between outlet and outlet, fitting and fitting, or outlet and fitting shall not contain more than the equivalent of four quarter bends (360 degrees, total), including those bends located immediately at the outlet or fitting.

348-11. Reaming. All cut ends of electrical metallic tubing shall be reamed 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 and within 3 feet of each outlet box, junction box, cabinet, or fitting.

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, outlet boxes or conduit bodies. Conductors, including splices and taps, shall not fill a conduit body to more than 75 percent of its cross-sectional area at any point. All splices and taps shall be made by approved methods.

ARTICLE 350 — FLEXIBLE METAL CONDUIT

350-1. Other Articles. Installations of flexible metal conduit shall comply with the applicable provisions of Articles 300, 333, and 346.

350-2. Use. Flexible metal conduit shall not be used: (1) in wet locations, unless conductors are of the lead-covered type or of other type approved for the specific conditions; nor (6) underground or embedded in poured concrete or aggregate.

350-3. Minimum Size. Flexible metal conduit less than ½-inch electrical trade size shall not be used.

Exception No. 3: Flexible metal conduit of ⅜-inch nominal trade size shall be permitted in lengths not in excess of 72 inches as a part of an approved assembly or for lighting fixtures.

Table 350-3. Maximum Number of Insulated Conductors in ⅜-In. Flexible Metal Conduit.*

Col. A = With fitting inside conduit.
Col. B = With fitting outside conduit.

Size AWG	Types RFH-2, SF-2		Types TF, T, XHHW, AF, TW, RUH, RUW		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 grounding conductor of the same AWG size shall be permitted.

350-4. Supports. Flexible metal conduit shall be secured by an approved means at intervals not exceeding 4½ feet and within 12 inches on each side of every outlet box or fitting.

Exception No. 1: Where flexible metal conduit is fished.

Exception No. 2: Lengths of not more than 3 feet at terminals where flexibility is necessary.

Exception No. 3: Lengths of not more than 6 feet 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 where both the conduit and the fittings are approved for the purpose. Where an equipment bonding jumper is required around flexible metal conduit, it shall be installed in accordance with Section 250-79.

Exception: Flexible metal conduit shall be permitted as a grounding means if the total length in any ground return path is 6 feet or less, the conduit is terminated in fittings approved for the purpose, and the circuit conductors contained therein are protected by overcurrent devices rated at 20 amperes or less.

350-6. Bends in Concealed Work. A run of conduit for concealed raceway, between outlet and outlet, fitting and fitting, or outlet and fitting, shall not contain more than the equivalent of four quarter bends (360 degrees total), including those bends located immediately at the outlet or fitting.

Angle connectors shall not be used for concealed raceway installations.

ARTICLE 353 — MULTIOUTLET ASSEMBLY

353-1. Other Articles. A multioutlet assembly shall comply with applicable provisions of Article 300.

See definition in Article 100 in the NEC.

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 unless approved for the purpose.

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, SWITCH AND JUNCTION BOXES, AND FITTINGS

A. Scope and General

370-1. Scope. This article covers the installation and use of boxes containing outlets, receptacles, switches or devices; junction or pull boxes and conduit bodies as required by Section 300-15. Fittings referred to in Section 300-15 used as outlet, junction or pull boxes shall conform with the provisions of this article depending on their use.

Installations in hazardous locations shall conform to Articles 500 through 517 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 not over 100 cubic inches shall be permitted only with open wiring on insulators, concealed knob-and-tube wiring, nonmetallic-sheathed cable, and with rigid nonmetallic conduit.

Nonmetallic boxes over 100 cubic inches manufactured with bonding means between all raceway and cable entries shall be permitted to be used with metal raceways and metal-sheathed cable.

370-4. Metal Boxes. Where used with knob-and-tube wiring or nonmetallic-sheathed cable, and mounted on or in contact with metal or metal lath ceilings, walls, or metallic surfaces, metal boxes shall be grounded.

B. Installation

370-5. Damp or Wet Locations. In damp or wet locations, boxes and fittings shall be so placed or equipped as to prevent moisture from entering or accumulating within the box or fitting. Boxes and fittings installed in wet locations shall be approved for the purpose.

For boxes in floors, see Section 370-17(b).

For protection against corrosion, see Section 300-6.

370-6. Number of Conductors in Switch, Outlet, Receptacle, Device, and Junction Boxes. 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, not counting fixture wires 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.

(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 fixture studs, cable clamps, or hickeys are contained in the box, the number of conductors shall be one less than shown in the tables; an additional deduction of one conductor shall be made for each 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. 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 provided by plaster rings, domed covers, extension rings, etc. that are marked with their volume in cubic inches.

Table 370-6(a). Metal Boxes

Box Dimension, Inches Trade Size or Type	Min. Cu. In. Cap.	Maximum Number of Conductors				
		No.14	No.12	No.10	No.8	No.6
4 x 1¼ Round or Octagonal	12.5	6	5	5	4	0
4 x 1½ Round or Octagonal	15.5	7	6	6	5	0
4 x 2⅛ Round or Octagonal	21.5	10	9	8	7	0
4 x 1¼ Square	18.0	9	8	7	6	0
4 x 1½ Square	21.0	10	9	8	7	0
4 x 2⅛ Square	30.3	15	13	12	10	6*
4 11/16 x 1¼ Square	25.5	12	11	10	8	0
4 11/16 x 1½ Square	29.5	14	13	11	9	0
4 11/16 x 2⅛ Square	42.0	21	18	16	14	6
3 x 2 x 1½ Device	7.5	3	3	3	2	0
3 x 2 x 2 Device	10.0	5	4	4	3	0
3 x 2 x 2¼ Device	10.5	5	4	4	3	0
3 x 2 x 2½ Device	12.5	6	5	5	4	0
3 x 2 x 2¾ Device	14.0	7	6	5	4	0
3 x 2 x 3½ Device	18.0	9	8	7	6	0
4 x 2⅛ x 1½ Device	10.3	5	4	4	3	0
4 x 2⅛ x 1⅞ Device	13.0	6	5	5	4	0
4 x 2⅛ x 2⅛ Device	14.5	7	6	5	4	0
3¾ x 2 x 2½ Masonry Box/Gang	14.0	7	6	5	4	0
3¾ x 2 x 3½ Masonry Box/Gang	21.0	10	9	8	7	0
FS—Minimum Internal Depth 1¾ Single Cover/Gang	13.5	6	6	5	4	0
FD—Minimum Internal Depth 2⅜ Single Cover/Gang	18.0	9	8	7	6	3
FS—Minimum Internal Depth 1¾ Multiple Cover/Gang	18.0	9	8	7	6	0
FD—Minimum Internal Depth 2⅜ Multiple Cover/Gang	24.0	12	10	9	8	4

* Not to be used as a pull box. For termination only.

(2) For combinations of conductor sizes shown in Table 370-6(a), the volume per conductor listed in Table 370-6(b) shall apply. 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 and the

maximum number of conductors permitted shall be computed using the volume per conductor listed in Table 370-6(b) and the deductions provided for in Section 370-6(a)(1). 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. 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

Where No. 6 conductors are installed the minimum wire bending space required in Table 373-6(a) shall be provided.

(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 to which it is attached. The maximum number of conductors permitted shall be the maximum number permitted by Table I, 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 370-6(b) and are supported in a rigid and secure manner.

370-7. Conductors Entering Boxes or Fittings. Conductors entering boxes 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 and Fittings. Where metal outlet boxes or fittings are installed with open wiring or concealed knob-and-tube wiring, conductors shall enter through insulating bushings or, in dry places, through flexible tubing extending from the last insulating support and firmly secured to the box or fitting. Where raceway or cable is installed with metal outlet boxes or fittings, the raceway or cable shall be secured to such boxes and fittings.

(c) Nonmetallic Boxes. 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 ¼ inch inside the box. Where nonmetallic-sheathed cable is used, the cable assembly, including the sheath, shall extend into the box no less than ¼ inch through a nonmetallic-sheathed cable knockout opening. Where nonmetallic-sheathed cable is used with single gang boxes and where

the cable is fastened within 8 inches of the box measured along the sheath and where the sheath extends into the box no less than ¼ inch, securing the cable to the box shall not be required. In all other instances individual conductors and cables shall be secured to nonmetallic boxes.

(d) Conductors No. 4 AWG or Larger. Installation shall comply with Section 373-6(c).

370-8. Unused Openings. Unused openings in boxes and fittings shall be effectively closed to afford protection substantially equivalent to that of the wall of the box or fitting. Metal plugs or plates used with nonmetallic boxes or fittings shall be recessed at least ¼ inch 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 ¼ inch. 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. Plaster surfaces that are broken or incomplete shall be repaired so there will be no gaps or open spaces at the edge of the box or fitting.

Exception: On walls or ceilings of concrete, tile, or other noncombustible material.

370-12. Exposed Surface Extensions. In making an exposed surface extension from an existing outlet of concealed wiring, a box or an extension ring shall be mounted over the original box and electrically and mechanically secured to it.

370-13. Supports. Boxes shall be securely and rigidly fastened to the surface upon which they are mounted, or securely and rigidly embedded in concrete or masonry. Where nails are used as a mounting means and pass through the interior of the box, they shall not be permitted to be more than ¼ inch from the back of the box. Boxes shall be supported from a structural member of the building either directly or by using a substantial and approved metal or wooden brace, or shall be supported as is otherwise provided in this section. If of wood, the brace shall not be less than nominal one-inch thickness. If of metal it shall be corrosion-resistant and shall not be less than No. 24 MSG.

Where mounted in new walls in which no structural members are provided or in existing walls in previously occupied buildings, boxes not over 100 cubic inches in size, specifically approved for the purpose, shall be affixed with approved anchors or clamps so as to provide a rigid and secure installation.

Threaded boxes or fittings not over 100 cubic inches in size that do not contain devices or support fixtures shall be considered adequately supported if two or more conduits are threaded into the box wrenchtight and are

supported within 3 feet of the box on two or more sides as is required by this section.

Threaded boxes or fittings not over 100 cubic inches in size shall be considered to be adequately supported if two or more conduits are threaded into the box wrenchtight and are supported as required by this section within 18 inches of the box.

370-14. Depth of Outlet Boxes. No box shall have an internal depth of less than ½ inch. Boxes intended to enclose flush devices shall have an internal depth of not less than 15/16 inch.

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 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.

See Section 410-18 for metal faceplates.

(b) 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) Covers of outlet boxes having holes through which flexible cord pendants pass shall be provided with bushings designed for the purpose or shall have smooth, well-rounded surfaces on which the cords may bear. 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. Floor boxes especially approved for the purpose shall be used for receptacles located in the floor.

Exception: Standard approved types of flush receptacle boxes shall be permitted where receptacles are located in elevated floors of show windows or other locations when the authority having jurisdiction judges them to be free from physical damage, moisture, and dirt.

370-18. Pull and Junction Boxes. Boxes and conduit bodies used as pull or junction boxes shall comply with (a), (c) and (d) of this section.

(a) Minimum Size. For raceways ¾ 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 8 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 6 times the trade diameter of the largest raceway. This distance shall be increased for additional entries by the amount of the sum of the diameters of all other raceway entries on the same wall of the box. The distance between raceway entries enclosing the same conductor shall not be less than 6 times the trade diameter of the larger raceway.

Exception: Where a conduit 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).

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 fill (of conduits 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.

See Section 373-6(c) for insulation of conductors at bushings.

(c) Covers. All pull boxes, junction boxes, and fittings shall be provided with covers approved for the purpose. Where metal covers are used, they shall comply with the grounding requirements of Section 250-42.

(d) Where permanent barriers are installed in a box, each section shall be considered as a separate box.

370-19. Junction, Pull and Outlet Boxes to Be Accessible. 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: Boxes approved for the purpose 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 of cabinets and cutout boxes.

A. Installation

373-2. Damp or 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 ¼-inch air space between the enclosure and the wall or other supporting surface. Cabinets or cutout boxes installed in wet locations shall be weatherproof.

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 ¼ inch. 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 ¼ inch 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 places, 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) and (c) below.

(b) Wire Bending Space at Terminals. Conductors shall not be deflected at a terminal unless bending space in accordance with Table 373-6(a) is provided.

(c) Insulated Bushings. 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 bushing providing a smoothly rounded insulating surface, unless the conductors are separated from the raceway fitting by substantial insulating material securely

fastened in place. Where conduit bushings are constructed wholly of insulating material, a locknut shall be installed both inside and outside the enclosure to which the conduit is attached. The insulating bushing or insulating material shall have a temperature rating not less than the insulation temperature rating of the installed conductors.

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
14-10	Not Specified
8-6	1½
4-3	2
2	2½
1	3
0-00	3½
000-0000	4

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 or barrier.

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 enclosures, wiring between switches and outlets shall be run with both polarities in the same enclosure.

(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 enclosed in boxes or cabinets approved for the purpose. The minimum wire bending space at terminals and minimum gutter space provided in switch enclosures shall be as required in Section 373-6.

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.

380-5. Time Switches, Flashers, and Similar Devices. Time switches, flashers, and similar devices need not be of the externally operable type. They shall be enclosed in metal boxes or cabinets.

Exception No. 2: Where enclosed in approved individual housings with no live parts exposed to the operator.

380-6. Position of Knife Switches.

(a) Single-Throw Knife Switches. Single-throw knife switches shall be so placed that gravity will not tend to close them. Single-throw knife switches, approved for use in the inverted position, shall be provided with a locking device that will ensure that the blades remain in the open position when so set.

(b) Double-Throw Knife Switches. Double-throw knife switches shall be permitted to be mounted so that the throw will be either vertical or horizontal. Where the throw is vertical, a locking device shall be provided, the blades remaining in the open position when so set.

380-7. Connection of Knife Switches. Single-throw knife switches shall be so connected that the blades are dead when the switch is in the open position.

380-8. Accessibility and Grouping.

(a) All switches and circuit breakers used as switches shall be 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 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 in thickness or of nonferrous metal not less than 0.040 inch in thickness. Faceplates of insulating material shall be noncombustible and not less than 0.10 inch in thickness but they shall be permitted to be less than 0.10 inch 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.

380-12. Grounding of Enclosures. Enclosures for switches or circuit breakers on circuits of over 150 volts to ground 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 follows:

(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.

(4) Snap switches rated 20 amperes or less directly connected to aluminum conductors shall be approved for the purpose and marked CO/ALR.

(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.

For switches controlling motors, see Sections 430-83, 430-109, and 430-110 in the NEC.

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 panelboards and distribution boards, and their enclosures, shall comply with the requirements of Articles 240, 250, 370, 380, and other articles that apply.

384-3. Support and Arrangement of Busbars and Conductors.

(c) Each panelboard, if used as service equipment, shall be provided with a main bonding jumper sized in accordance with Section 250-79(c) or the equivalent placed within the service disconnect section for connecting the grounded service conductor on its supply side to the panelboard frame.

B. Panelboards

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.

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 42 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) 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 that of the panelboard.

Exception No. 2: Individual protection for lighting and appliance branch-circuit panelboards is not required where such panelboards are used as service equipment in supplying an individual residential occupancy.

(b) Panelboards equipped with snap switches rated at 30 amperes or less, shall have overcurrent protection not in excess of 200 amperes.

(c) 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.

(d) Where a panelboard is supplied through a transformer, the overcurrent protection required in (a) and (b) above shall be located on the secondary side of the transformer.

Exception: A panelboard supplied by the secondary side of a single-phase transformer having a two-wire (single-voltage) secondary shall be considered as protected by overcurrent protection provided on the primary (supply) side of the transformer, provided this protection is in accordance with Section 450-3(b)(1) in the NEC and does not exceed the value determined by multiplying the panelboard rating by the secondary-to-primary voltage ratio.

(e) A three phase disconnect or overcurrent device shall not be connected to the bus of any panelboard that has less than three phase buses.

This is intended to prohibit the use of "delta breakers" in panelboards.

384-17. Panelboards in Damp or Wet Locations. Panelboards in damp or wet locations shall be installed to comply with Section 373-2.

384-18. Enclosure. Panelboards shall be mounted in cabinets, cutout boxes, or enclosures approved for the purpose and shall be dead front.

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.

384-27. Grounding of Panelboards. Panelboard cabinets shall be grounded in the manner specified in Article 250 or Section 384-3(c). An approved terminal bar for equipment grounding conductors shall be provided and secured inside of the cabinet for the attachment of all the feeder and branch-circuit equipment grounding conductors, where the panelboard is used with nonmetallic raceway or cable, or where separate grounding conductors are provided. The terminal bar shall be bonded to the cabinet or panelboard frame and shall not be connected to the neutral bar in other than service equipment.

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) 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; or (7) prevention of the transmission of noise or vibration; or (8) appliances where the fastening means and mechanical connections are designed to permit removal for maintenance and repair.

(b) Where used as permitted in sub-sections (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 an approved 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; or (5) where concealed behind building walls, ceilings, or floors.

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).

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 which shall conform to the provisions of this article.

Exception: As otherwise provided in this Code.

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.

B. Fixture Locations

410-4. Fixtures in Specific Locations.

(a) Wet and Damp Locations. Fixtures installed in wet or damp locations shall be approved for the purpose and shall be so constructed or installed that water cannot enter or accumulate in wireways, lampholders, or other electrical parts. 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.

See Article 680 in the NEC for lighting fixtures in swimming pools, fountains, and similar installations.

(b) Corrosive Locations. Fixtures installed in corrosive locations shall be of a type approved for such locations.

See Section 210-7 for receptacles in fixtures.

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 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) Location. A fixture in a clothes closet shall be permitted to be installed:

(1) On the wall above the closet door, provided the clearance between the fixture and a storage area where combustible material may be stored within the closet is not less than 18 inches, or

(2) On the ceiling over an area which is unobstructed to the floor, maintaining an 18-inch clearance horizontally between the fixture and a storage area where combustible material may be stored within the closet.

A flush recessed fixture equipped with a solid lens shall be considered outside the closet area.

(b) Pendants. Pendants shall not be installed in clothes closets.

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 approved for the purpose.

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. Where electric-discharge lighting fixtures are supported independently of the outlet box, they shall be connected through metal raceways, metal-clad cables, or nonmetallic-sheathed cables. It shall be permissible to suspend 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.

D. Fixture Supports

410-15. Supports — General. Fixtures, lampholders, and receptacles shall be securely supported. A fixture that weighs more than 6 pounds or

exceeds 16 inches 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 shall be supported independently of the outlet box.

(b) 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 so supported shall be securely fastened to the ceiling framing member.

(c) Raceway Fittings. Raceway fittings used to support lighting fixtures shall be approved for the purpose.

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) 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) 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.

410-21. Methods of Grounding. Equipment shall be considered grounded where mechanically connected in a permanent and effective manner to metal raceway, the armor of armored cable, mineral-insulated metal-sheathed cable, and the continuous sheath of Type MC cable, the grounding conductor in nonmetallic-sheathed cable, or to a separate grounding conductor sized in accordance with Table 250-95, provided that the raceway, armor, or grounding conductor is grounded in a manner specified in Article 250.

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.

410-26. Conductors for Movable Parts.

(a) Stranded conductors shall be used for wiring on fixture chains and on other movable or flexible parts.

(b) Conductors shall be so arranged that the weight of the fixture or movable parts will not put a tension on the conductors.

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.

410-30. Connections, Splices, and Taps.

(a) 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.

(b) Fixture Stems. Splices and taps shall not be located within fixture arms or stems.

(c) Splices and Taps. No unnecessary splices or taps shall be made within or on a fixture.

For approved means of making connections, see Section 110-14.

(d) 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.

410-31. Fixtures As Raceways. Fixtures shall not be used as a raceway for circuit conductors.

Exception No. 1: Fixtures approved 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.

See Article 100 in the NEC for definition of multiwire branch circuit.

Branch-circuit conductors within 3 inches of a ballast within the ballast compartment shall be recognized for use at temperatures not lower than 90°C (194°F), such as Types RHH, THW, THHN, FEP, FEPB, SA, XHHW and AVA.

410-32. 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 identified grounded conductor, where connected to a screw-shell lampholder, shall be connected to the screw shell.

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 used on unidentified two-wire circuits tapped from the ungrounded conductors of multiwire circuits, the switching device of lampholders of the switched type shall simultaneously disconnect both conductors of the circuit in accordance with Section 210-10.

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.

Exception: The use of receptacles of 10-ampere, 250-volt rating used in nonresidential occupancies for the supply of equipment other than portable hand tools, portable hand lamps, and extension cords shall be permitted.

(b) Faceplates. Metal faceplates shall be of ferrous metal not less than 0.030 inch in thickness or of nonferrous metal not less than 0.040 inch in thickness. Metal faceplates shall be grounded. Faceplates of insulating material shall be noncombustible and not less than 0.10 inch in thickness but shall be permitted to be less than 0.10 inch in thickness if formed or reinforced to provide adequate mechanical strength.

(c) 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 from metal faceplates. Face-plates shall be installed so as to seat against mounting surfaces. Boxes shall be installed in accordance with Section 370-10.

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 likely to be used with other than portable tools or other portable equipment not usually left connected to the outlet indefinitely.

(c) 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.

(d) 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.

N. Special Provisions for Flush and Recessed Fixtures

410-64. General. Fixtures installed in recessed cavities in walls or ceilings shall be of a type approved for the purpose and shall comply with Sections 410-65 through 410-67.

410-65. Temperature.

(a) Combustible Material. Fixtures shall be so constructed or 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 approved for that service.

410-66. Clearance. Recessed portions of enclosures, other than at points of support, shall be spaced at least ½ inch from combustible material. Thermal insulation shall not be installed within 3 inches of the recessed fixture enclosure, wiring compartment or ballast and shall not be so installed above the fixture as to entrap heat and prevent the free circulation of air unless the fixture is otherwise approved for the purpose.

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 one foot from the fixture. Such tap conductors shall be in a suitable metal raceway of at least 4 feet but not more than 6 feet in length.

Q. Special Provisions for Electric-Discharge Lighting Systems of 1000 Volts or Less

410-73. General.

(a) 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) Where fluorescent fixtures are installed indoors, the ballasts shall have thermal protection integral within the ballast. Replacements for these ballasts shall also be integrally protected.

Exception to (e) above: Fluorescent fixtures with simple reactance ballasts.

410-75. Voltages — Dwelling Occupancies.

(a) Equipment having an open-circuit voltage exceeding 1000 volts shall not be installed in dwelling occupancies.

(b) 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 approved for this condition or shall be spaced not less than 1½ inches from the surface of the fiberboard. Where such fixtures are partially or wholly recessed, the provisions of Sections 410-64 through 410-67 shall apply.

Combustible low-density cellulose fiberboard includes sheets, panels, and tiles that have a density of 20 pounds per cubic foot 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 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 Method of Test for Surface Burning Characteristics of Building Materials, ANSI A2.5-1970.

ARTICLE 422 — APPLIANCES

A. General

422-1. Scope. This article covers electric appliances used in any occupancy. Equipment shall be of a type approved for the purpose and location.

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

422-5. 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 approved 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.

422-6. 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

422-7. General. All appliances shall be installed in an approved manner.

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, for maintenance or repair.

(d) Specific Appliances.

(1) Electrically operated kitchen waste disposers intended for dwelling unit use and provided with a type S, SO, ST, STO, SJO, SJT, SJTO, 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 and not over 36 inches.

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, SO, ST, STO, SJO, SJT, SJTO 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.

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; (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.

See Listing Requirements for Relief Valves and Automatic Gas Shutoff Devices for Hot Water Supply Systems. (ANSI Z21.22-1972.)

Exception: Water heaters with supply water temperature of 180°F or above and a capacity of 60 kW or above, and water heaters with a capacity of one gallon or less, approved for the purpose.

(b) Storage-Type Water Heaters. All fixed storage water heaters having a capacity of 120 gallons or less shall be considered a continuous duty load.

For branch-circuit sizing see Section 422-5(a), Exception No. 2.

422-16. Grounding. Metal frames of electrically heated appliances, operating on circuits over 150 volts to ground, shall be grounded in the manner specified in Article 250.

Exception: Where this is impracticable, grounding may be omitted by special permission, in which case the frames shall be permanently and effectively insulated from the ground.

Refrigerators and freezers shall comply with the requirements of Sections 250-42, 250-43, and 250-45. Electric ranges, wall-mounted ovens, counter-mounted cooking units and clothes dryers shall comply with the requirements of Sections 250-57 and 250-60.

422-17. Wall-Mounted Ovens and Counter-Mounted Cooking Units.

(a) Wall-mounted ovens and counter-mounted cooking units complete with provisions for mounting and for making electrical connections shall be permitted to be cord- and plug-connected or permanently connected.

(b) A separable connector or a plug and receptacle combination in the supply line to an oven or cooking unit used only for ease in servicing or for installation 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. Other Installation Methods. Appliances employing methods of installation other than covered by this article may 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 as required by 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) For permanently connected appliances rated at not over 300 volt amperes or ⅛ hp, the branch-circuit overcurrent device shall be permitted to serve as the disconnecting means.

(b) For permanently connected appliances of greater rating the branch-circuit switch or circuit breaker shall be permitted to serve as the disconnecting means where readily accessible to the user of the appliance.

For motor driven appliances of more than ⅛ horsepower, see Section 422-26.

Exception: Appliances employing unit switches as permitted by Section 422-24.

422-22. Disconnection of Cord- and Plug-Connected Appliances.

(a) For cord- and plug-connected appliances, a separable connector or an attachment plug and receptacle shall be permitted to serve as the disconnecting means.

(b) 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) The rating of a receptacle or of a separable connector shall not be less than the rating of any appliance connected thereto.

422-24. 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 disconnecting means shall be permitted to be outside the dwelling unit in which the appliance is installed. In this case an individual switch for the dwelling unit shall be permitted.

(c) One-Family Dwellings. In one-family dwellings, the service disconnecting means shall be permitted to be used.

422-25. Switch and Circuit Breaker to Be Indicating. Switches and circuit breakers used as disconnecting means shall be of the indicating type.

422-26. 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 ⅛ 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 422-24 (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.

422-27. Overcurrent Protection.

(a) Appliances shall be considered as protected against overcurrent if supplied by branch circuits as specified in (e) below and in Sections 422-5 and 422-6.

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 440-3 in the NEC.

(b) 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) If the branch circuit supplies a single nonmotor-operated appliance, rated at 16.7 amperes or more, the overcurrent device rating shall not exceed 150 percent of the appliance rating.

(f) Electric heating appliances employing resistance-type heating elements rated more than 48 amperes shall have the heating elements sub-

divided. 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; and (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 422-27(b).

E. Marking of Appliances

422-30. Nameplate.

(a) 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.

See Section 422-27(a) Exception for overcurrent protection requirements.

(b) 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) 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 circuit size 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 circuit size and maximum rating of the circuit overcurrent protective device are not more than 15 amperes and complies with Section 422-30.

(b) 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 ⅛ hp or less or a nonmotor load one 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. Equipment shall be of a type approved for the purpose and location where installed. 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 size of branch-circuit conductors and overcurrent protective devices supplying fixed electric space heating equipment consisting of resistance elements with or without a motor shall be computed on the basis of 125 percent of the total load of the motors and the heaters. 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 No. 3.

The size of the branch-circuit conductors and overcurrent protective devices supplying fixed electric space heating equipment consisting of mechanical refrigeration 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.

424-10. Special Permission. Fixed electric space heating equipment and systems installed by methods other than covered by this article may be used 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) Fixed electric space heating equipment shall not be used where exposed to severe physical damage unless adequately protected.

(b) 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.

See Section 110-11 for equipment exposed to deteriorating agents.

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 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 and on the supply side of the supplementary overcurrent protection device(s), and in addition shall comply with either (1) or (2) below.

(1) Heater Containing No Motor Rated Over ⅛ Horsepower. The above disconnecting means or unit switches complying with Section 424-19(b) (3) 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 ⅛ Horsepower.

a. The above disconnecting means shall be permitted to serve as the required disconnecting means for both the motor controller(s) and heater if this 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(b) (3) shall be permitted.

(b) Heating Equipment Without Supplementary Overcurrent Protection.

(1) Without Motor or With Motor Not Over ⅛ Horsepower. For fixed electric space heating equipment without a motor rated over ⅛

horsepower, the branch-circuit switch or circuit breaker shall be permitted to serve as the disconnecting means, where readily accessible for servicing.

(2) Over ⅛ Horsepower. For motor-driven electric space heating equipment with a motor rated over ⅛ horsepower a disconnecting means shall be located within sight from the motor controller.

Exception: As permitted by Section 424-19(a) (2).

(3) Unit Switches as Disconnecting Means. Unit switches with a marked "off" position that are part of a fixed heater and disconnect 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 fixed heater is installed.

c. One-Family Dwellings. In one-family dwelling units the service disconnecting means shall be permitted to be the other disconnecting means.

424-20. Thermostatically Controlled Switching Devices.

(a) 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 and operate remote control circuits shall not be required to meet the requirements of (a) above. 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 considered as protected against overcurrent where supplied by one of the branch circuits in Article 210.

(b) Resistance Elements. Electric space heating equipment 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.

Exception: As provided in Section 424-72(a) in the NEC.

(c) Overcurrent Protective Devices. The supplementary overcurrent protective devices 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.

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.

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. The ampacity of field wired conductors between the heater and the supplementary overcurrent protective devices shall not be less than 100 percent of the rating or setting of the overcurrent protective device protecting the subdivided circuit(s).

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 ⅛ 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 and Panels

424-34. Heating Cable and Heating Panel Construction. Heating cables and heating panels shall be furnished complete with factory-assembled nonheating leads at least 7 feet in length.

424-35. Marking of Heating Cables and Panels. Each unit shall be marked with the identifying name or identification symbol, catalog number, ratings in volts and watts, or in volts and amperes.

(a) Heating Cables. Each unit length of heating cable shall have a permanent legible marking on each nonheating lead located within 3 inches of the terminal end. The lead wire shall have the following color identification: 120-volt nominal, yellow; 208-volt nominal, blue; 240-volt nominal, red; and 277-volt nominal, brown.

(b) Heating Panels. Heating panels shall be permanently marked in a location that is readily visible prior to application of panel finish.

424-36. Clearances of Wiring in Ceilings. Wiring located above heated ceilings shall be spaced not less than 2 inches above the heated ceiling and shall be considered as operating at an ambient of 50°C. 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 shall not require correction for temperature.

424-37. Clearances of Branch-Circuit Wiring in Walls.

(a) Exterior Walls. Where located in exterior walls, wiring shall be located outside the thermal insulation.

(b) Interior Walls. Where heating panels are located in interior walls or partitions, any wiring behind the heating panels shall be considered as operating at an ambient of 40°C (104°F); and the ampacity of conductors shall be computed on the basis of the correction factors given in Table 310-16.

424-38. Area Restrictions.

(a) Heating cables and panels shall not extend beyond the room or area in which they originate.

(b) Cables and panels 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) This provision shall not prevent the use of cable or panels 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 panels and cables shall be separated at least 8 inches 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 two inches 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 or panel will be covered by any surface mounted lighting 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) 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 of cable not exceeding 2¾ watts per foot shall be installed not less than 1½ inches on centers.

(c) 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.

See also (f) below.

(d) All heating cables, the splice between the heating cable and nonheating leads, and 3-inch 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) The entire ceiling surface shall have a finish of thermally noninsulating sand plaster having a nominal thickness of ½ inch, or other noninsulating material approved for the purpose and applied according to specified thickness and directions.

(f) Cables shall be secured at intervals not exceeding 16 inches 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 approved for the purpose shall be permitted to be secured at intervals not to exceed six feet by approved means.

(g) In dry board installations, the entire ceiling below the heating cable shall be covered with gypsum board not exceeding ½-inch 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) Cables shall be kept free from contact with metal or other electrical conductive surfaces.

(i) In dry-board applications, cable shall be installed parallel to the joist, leaving a clear space centered under the joist of 2½ inches (width) between centers of adjacent runs of cable. Crossing of joist by cable shall be kept to a minimum. Surface layer of gypsum board shall be mounted so that the nails or other fasteners do not pierce the heating cable.

Where practicable, cables shall cross joists only at the ends of a room.

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 and Panels.

(a) Free nonheating leads of cables and panels 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) Not less than 6 inches 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 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 of free lead within the box.

(d) Excess nonheating leads of heating panels shall be permitted to be cut to the required length. They shall meet the installation requirements of the wiring method employed in accordance with Section 424-43(a). Nonheating leads shall be considered to be an integral part of an approved fixed electric space heating panel and not subject to the ampacity requirements of Section 424-3(b) for branch circuits.

424-44. Installation of Panels or Cables in Concrete or Poured Masonry Floors.

(a) Panels or heating units shall not exceed 33 watts per square foot of heated area or 16½ watts per linear foot of cable.

(b) The spacing between adjacent runs of cable shall not be less than one inch on centers.

(c) Cables shall be secured in place by nonmetallic frames or spreaders or other approved means while the concrete or other finish is applied.

Cables, units, and panels shall not be installed where they bridge expansion joints unless protected from expansion and contraction.

(d) 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.

(e) Leads shall be protected where they leave the floor by rigid metal conduit, intermediate metal conduit, electrical metallic tubing, or by other approved means.

(f) Bushings or approved fittings shall be used where the leads emerge within the floor slab.

424-45. Inspection and Tests. Cable installations shall be made with due care to prevent damage to the cable assembly and shall be inspected and approved before cables are covered or concealed.

424-46. Panels — General. Sections 424-46 through 424-48 cover only heating panels of less than 25 watts per square foot assembled together in the field to form a heating installation in one room or area using approved methods of interconnection. Such an installation shall be connected by a recognized wiring method.

424-47. Panels to Be Complete Units. Panels shall be installed as complete units unless approved for field cutting in a recognized manner.

424-48. Installation. Panels shall be installed in an approved manner. Nails, staples, or other electrically conductive fasteners shall not be used where they penetrate current-carrying parts.

Exception: Insulated fasteners shall be permitted with systems for which they are recognized.

F. Duct Heaters

424-57. General. Part F shall apply to any heater mounted in the air stream of a forced-air system where the air moving unit is not provided as an integral part of the equipment.

424-58. Approved. Heaters installed in an air duct shall be approved for the purpose and installed in the approved manner.

424-59. Air Flow. Means shall be provided to assure uniform and adequate air flow over the face of the heater.

Heaters installed within 4 feet of a fan outlet, elbows, baffle plates, or other obstruction in duct work may require turning vanes, pressure plates, or other devices on the inlet side of the duct heater to assure an even distribution of air over the face of the heater.

424-60. Elevated Inlet Temperature. Duct heaters intended for use with elevated inlet air temperature (such as heat pumps) shall be approved for the purpose and so marked.

424-61. Installation of Duct Heaters with Heat Pumps and Air Conditioners. Heat pumps and air conditioners having duct heaters closer than 4 feet to the heat pump or air conditioner shall have both the duct heater and heat pump or air conditioner approved for such installation and so marked.

424-62. Condensation. Duct heaters used with air conditioners or other air-cooling equipment that may result in condensation of moisture shall be approved for use with air conditioners.

424-63. Fan Circuit Interlock. Means shall be provided to ensure that the fan circuit is energized when the first heater circuit is energized. However, time or temperature controlled delay in energizing the fan motor shall be permitted.

424-64. Limit Controls. Each duct heater shall be provided with an approved, integral, automatic-reset temperature-limiting control or controllers to de-energize the circuit or circuits.

In addition, an integral independent supplementary control or controllers shall be provided in each duct heater that will disconnect a sufficient number of conductors to interrupt current flow. This device shall be manually resettable or replaceable.

424-65. Location of Disconnecting Means. Duct heater controller equipment shall be accessible with the disconnecting means installed at or within sight from the controller.

Exception: As permitted by Section 424-19(a).

424-66. Installation. Duct heaters shall be installed in accordance with the manufacturer's instructions in a manner so that operation will not create a hazard to persons or property. Furthermore, duct heaters shall be located with respect to building construction and other equipment so as to permit access to the heater. Sufficient clearance shall be maintained to permit replacement of controls and heating elements and for adjusting and cleaning of controls and other parts requiring such attention. See Section 110-16.

For additional installation information, see Air Conditioning and Ventilating Systems NFPA 90A-1976 (ANSI) and Warm Air Heating and Air Conditioning Systems NFPA 90B-1976 (ANSI).

G. Resistance-Type Boilers

Installation shall conform to the requirements of the National Electrical Code.

ARTICLE 440 — AIR-CONDITIONING AND REFRIGERATING EQUIPMENT

For Air Conditioning and Refrigerating Equipment Other than Air Conditioners see Article 440 of the National Electrical Code.

G. Provisions for Room Air Conditioners

440-60. General. The provisions of Part G shall apply to electrically energized room air conditioners that control temperature and humidity. For the purpose of Part G, a room air conditioner (with or without provisions for heating) shall be considered as an alternating-current appliance of the air cooled window, console, or in-wall type that is installed in the conditioned room and which incorporates a hermetic refrigerant motor-compressor(s). The provisions of Part G cover equipment rated not over 250 volts, single phase, and such equipment shall be permitted to be cord-and-attachment plug-connected.

A room air conditioner that is rated 3 phase or rated over 250 volts shall be directly connected to a wiring method recognized in Chapter 3 of the NEC and provisions of Part G shall not apply.

440-61. Grounding. Room air conditioners shall be grounded in accordance with Sections 250-42, 250-43, and 250-45.

440-62. Branch-Circuit Requirements.

(a) A room air conditioner shall be considered as a single motor unit in determining its branch-circuit requirements when all the following conditions are met:

(1) It is cord-and-attachment plug-connected.

(2) Its rating is not more than 40 amperes and 250 volts, single phase.

(3) Total rated-load current is shown on the room air conditioner nameplate rather than individual motor currents, and

(4) The rating of the branch-circuit short-circuit and ground-fault protective device does not exceed the ampacity of the branch-circuit conductors or the rating of the receptacle, whichever is less.

(b) The total marked rating of a cord-and-attachment plug-connected room air conditioner shall not exceed 80 percent of the rating of a branch circuit where no other loads are supplied.

(c) The total marked rating of a cord-and-attachment plug-connected room air conditioner shall not exceed 50 percent of the rating of a branch circuit where lighting units or other appliances are also supplied.

440-63. Disconnecting Means. An attachment plug and receptacle shall be permitted to serve as the disconnecting means for a single-phase room air conditioner rated 250 volts or less if: (1) the manual controls on the room air conditioner are readily accessible and located within 6 feet of the floor, or (2) an approved manually operable switch is installed in a readily accessible location within sight from the room air conditioner.

440-64. Supply Cords. Where a flexible cord is used to supply a room air conditioner, the length of such cord shall not exceed: (1) 10 feet for a nominal 120-volt rating, or (2) 6 feet for a nominal 208- or 240-volt rating.

ARTICLE 545 — MANUFACTURED BUILDING

Installations shall conform to the requirements of Article 545 of the 1978 National Electrical Code (NFPA No. 70-1978).

ARTICLE 680 — SWIMMING POOLS, FOUNTAINS AND SIMILAR INSTALLATIONS

Installations shall conform to the requirements of Article 680 of the 1978 National Electrical Code (NFPA No. 70-1978).

ARTICLE 725 — CLASS 1, CLASS 2, AND CLASS 3 REMOTE-CONTROL, SIGNALING, AND POWER-LIMITED CIRCUITS

A. Scope and General

725-1. Scope. This article covers remote-control, signaling, and power-limited circuits that are not an integral part of a device or appliance.

The circuits described herein are characterized by usage and electrical power limitations which differentiate them from light and power circuits and, therefore, special consideration is given with regard to minimum wire sizes, derating factors, overcurrent protection, and conductor insulation requirements.

725-3. Classifications. A remote-control, signaling, or power-limited circuit is the portion of the wiring system between the load side of the overcurrent device or the power-limited supply and all connected equipment, and shall be Class 1, Class 2, or Class 3 as defined in (a) and (b) below.

(a) Class 1 Circuits. Circuits that comply with Part B of this article and in which the voltage and power limitations are in accordance with Section 725-11.

(b) Class 2 and Class 3 Circuits. Circuits that comply with Part C of this article and in which the voltage and power limitations are in accordance with Section 725-31.

725-4. Safety Control Equipment. Remote-control circuits to safety control equipment shall be Class 1 if the failure of the equipment to operate introduces a direct fire or life hazard. Room thermostats, water temperature regulating devices, and similar controls used in conjunction with electrically controlled household heating and air conditioning shall not be considered safety-control equipment.

725-5. Communication Cables. Class 1 circuits shall not be run in the same cable with communication circuits. Class 2 and Class 3 circuit conductors shall be permitted in the same cable with communication circuits, in which case the Class 2 and Class 3 circuits shall be classified as communication circuits and shall meet the requirements of Article 800 in the NEC.

B. Class 1 Circuits

725-11. Power Limitations for Class 1 Circuits.

(a) Class 1 Power-Limited Circuits. These circuits shall be supplied from a source having a rated output of not more than 30 volts and 1000 volt-amperes. The source shall be protected by overcurrent devices rated at not more than 167 percent of the volt-ampere rating of the source divided by the rated voltage. The overcurrent devices and their mounting shall be approved for the purpose and shall not be interchangeable with overcurrent devices of a higher rating. The overcurrent device shall be permitted to be an integral part of the power supply.

(1) Transformers. Transformers used to supply power-limited Class 1 circuits shall comply with Article 450 in the NEC.

(2) Other Power Sources. To comply with the 1000 volt-ampere limitation, power sources other than transformers shall not exceed a maximum power output of 2500 volt-amperes, and the product of the maximum current and maximum voltage shall not exceed 10,000 volt-amperes with the overcurrent protection by-passed.

(b) Class 1 Remote-Control and Signaling Circuits. Class 1 remote-control and signaling circuits shall not exceed 600 volts; however, the power output of the source shall not be required to be limited.

725-12. Overcurrent Protection.

(a) Conductors Larger than No. 14. Conductors larger than No. 14 shall be protected against overcurrent in accordance with the ampacities given in Table 310-16.

(b) Conductors of Nos. 18, 16, and 14. Conductors of Nos. 18, 16, and 14 shall be considered as protected by overcurrent devices of not over 20 amperes rating.

Exception No. 1 for (a) and (b) above: Where other articles of this Code permit or require other overcurrent protection.

See Section 430-72 in the NEC for motors and Section 620-61 in the NEC for elevators, escalators and moving walks.

Exception No. 2 for (a) and (b) above: In Class 1 power-limited circuits having main overcurrent protection, the branch circuits shall not be required to have individual overcurrent protection.

725-13. Location of Overcurrent Devices. Overcurrent devices shall be located at the point where the conductor to be protected receives its supply.

Exception: Where the overcurrent device protecting the larger conductor also protects the smaller conductor.

725-14. Wiring Method. Installations of Class 1 circuits shall be in accordance with the appropriate articles in Chapter 3 in the NEC.

Exception No. 1: As provided in Sections 725-15 through 725-17.

Exception No. 2: Where other articles of this Code permit or require other methods.

725-15. Conductors of Different Circuits in Same Enclosure, Cable, or Raceway. Class 1 circuits shall be permitted to occupy the same enclosure, cable, or raceway without regard to whether the individual circuits are alternating current or direct current, provided all conductors are insulated for the maximum voltage of any conductor in the same enclosure, cable, or raceway only where the equipment is functionally associated.

725-16. Conductors.

(a) Sizes and Use. Conductors of Nos. 18 and 16 shall be permitted to be used provided they supply loads that do not exceed the ampacities given in Section 402-5 in the NEC and are installed in a raceway or a cable approved for the purpose. Conductors larger than No. 16 shall not supply loads greater than the ampacities given in Table 310-16. Flexible cords shall comply with Article 400.

(b) Insulation. Insulation on conductors shall be suitable for 600 volts. Conductors larger than No. 16 shall comply with Article 310. Conductors in sizes No. 18 and 16 shall be Types RFH-2, FFH-2, TF, TFF, TFN, TFFN, PF, PFF, PGF, PGFF, PTF, PTFF, SF-2, SFF-2, PAF, PAFF, ZF, or ZFF. Conductors with other types and thickness of insulation shall be permitted if approved for the purpose.

725-17. Number of Conductors in Raceways, Cable Trays, and Cables, and Derating.

(a) Where only Class 1 circuits are in a raceway, the number of conductors shall be determined in accordance with Section 300-17. The derating factors given in Note 8 to Table 310-16 shall apply only if such conductors carry continuous loads.

(b) Where power-supply conductors and Class 1 circuit conductors are permitted in a raceway in accordance with Section 725-15, the number of conductors shall be determined in accordance with Section 300-17. The derating factors given in Note 8 to Table 310-16 shall apply as follows:

(1) To all conductors when the Class 1 circuit conductors carry continuous loads and where the total number of conductors is more than three.

(2) To the power-supply conductors only, when the Class 1 circuit conductors do not carry continuous loads and where the number of power-supply conductors is more than three.

725-18. Physical Protection. Where damage to remote-control circuits of safety control equipment would introduce a hazard, as covered in Section 725-4, all conductors of such remote-control circuits shall be installed in rigid metal conduit, intermediate metal conduit, electrical metallic tubing, Type MI cable, Type MC cable, or be otherwise suitably protected from physical damage.

725-19. Circuits Extending Beyond One Building. Class 1 circuits that extend aerially beyond one building shall also meet the requirements of Article 225 in the NEC.

725-20. Grounding. Class 1 circuits and equipment shall be grounded in accordance with Article 250.

C. Class 2 and Class 3 Circuits

725-31. Power Limitations of Class 2 and Class 3 Circuits. The power for Class 2 and Class 3 circuits shall be either inherently limited requiring no overcurrent protection, or limited by a combination of a power source and overcurrent protection as specified in Table 725-31(a) for AC circuits and Table 725-31(b) for DC circuits.

Table 725-31(a). Power Limitations for Alternating Current (Class 2 and Class 3 Circuits)

		Inherently Limited Power Source (Overcurrent protection not required)				Not Inherently Limited Power Source (Overcurrent protection required)			
Circuit		Class 2			Class 3	Class 2		Class 3	
Circuit Voltage V_{max} (Note 1)		0-20†	Over 20-30†	0-150	Over 30-100	0-20†	Over 20-30†	Over 30-100	Over 100-150
Power Limitation $(VA)_{max}$ (Note 1) (Volt-Amps)		—	—	—	—	250 (see Note 3)	250	250	N.A.
Current Limitation I_{max} (Note 1) (Amps)		8.0	8.0	0.005	$150/V_{max}$	$1000/V_{max}$	$1000/V_{max}$	$1000/V_{max}$	1.0
Maximum Overcurrent Protection (Amps)		—	—	—	—	5.0	$100/V_{max}$	$100/V_{max}$	1.0
Power Source Maximum Nameplate Ratings	VA (Volt-Amps)	$5.0 \times V_{max}$	100	$0.005 \times V_{max}$	100	$5.0 \times V_{max}$	100	100	100
	Current (Amps)	5.0	$100/V_{max}$	0.005	$100/V_{max}$	5.0	$100/V_{max}$	$100/V_{max}$	$100/V_{max}$
Supply Conductors and Cables		See Section 725-37							
Circuit Conductors and Cables		See Section 725-40							

† Voltage ranges shown are for sinusoidal AC in indoor locations or where wet contact is not likely to occur. For nonsinusoidal or wet contact conditions see Note 2.

Table 725-31(b). Power Limitations for Direct Current (Class 2 and Class 3 Circuits)

		Inherently Limited Power Source (Note 4) (Overcurrent protection not required)					Not Inherently Limited Power Source (Overcurrent protection required)			
Circuit		Class 2				Class 3	Class 2		Class 3	
Circuit Voltage V_{max} (Note 1)		0-20††	Over 20-30††	Over 30-60††	0-150	Over 60-100	0-20††	Over 20-60††	Over 60-100	Over 100-150
Power Limitation $(VA)_{max}$ (Note 1) (Volt-Amps)		—	—	—	—	—	250 (see Note 3)	250	250	N.A.
Current Limitation I_{max} (Note 1) (Amps)		8.0	8.0	$150/V_{max}$	0.005	$150/V_{max}$	$1000/V_{max}$	$1000/V_{max}$	$1000/V_{max}$	1.0
Maximum Over-current Protection (Amps)		—	—	—	—	—	5.0	$100/V_{max}$	$100/V_{max}$	1.0
Power Source Maximum Name-plate Ratings	VA (Volt-Amps)	$5.0 \times V_{max}$	100	100	$0.005 \times V_{max}$	100	$5.0 \times V_{max}$	100	100	100
	Current (Amps)	5.0	$100/V_{max}$	$100/V_{max}$	0.005	$100/V_{max}$	5.0	$100/V_{max}$	$100/V_{max}$	$100/V_{max}$
Supply Conductors and Cables		See Section 725-37				Circuit Conductors and Cables	See Section 725-40			

†† Voltage ranges shown are for continuous DC in indoor locations or where wet contact is not likely to occur. For interrupted DC or wet contact conditions see Note 5.

Notes for Tables 725-31(a) and (b)

Note 1. V_{max}: Maximum output voltage regardless of load with rated input applied. I_{max}: Maximum output after one minute of operation under any noncapacitive load, including short circuit, and with overcurrent protection bypassed if used. VA_{max}: Maximum volt-ampere output regardless of load and overcurrent protection bypassed if used. **Note 2.** For nonsinusoidal AC, V_{max} shall be not greater than 42.4 volts peak. Where wet contact (immersion not included) is likely to occur, V_{max} shall be not greater than: 15 volts for sinusoidal AC; 21.2 volts peak for nonsinusoidal AC. **Note 3.** If the power source is a transformer, $(VA)_{max}$ is 350 or less when V_{max} is 15 or less. **Note 4.** A dry cell battery shall be considered an inherently limited power source provided the voltage is 30 volts or less and the capacity is equal to or less than that available from series connected No. 6 carbon zinc cells. **Note 5.** For DC interrupted at a rate of 10- to 200-Hz. V_{max} shall not be greater than 24.8 volts. Where wet contact (immersion not included is likely to occur, V_{max} shall not be greater than: 30 volts for continuous DC; 12.4 volts for DC that is interrupted at a rate of 10- to 200-Hz.

725-32. Interconnection of Power Supplies. Class 2 or Class 3 power supplies shall not be paralleled or otherwise interconnected unless approved for the purpose.

725-34. Marking. A Class 2 or Class 3 power supply unit shall be durably marked where plainly visible to indicate the class of supply and its electrical rating.

725-35. Overcurrent Protection. Where overcurrent protection is required, such protection and its mounting shall be approved for the purpose and shall not be interchangeable with protection of higher rating. The overcurrent protection shall be permitted as an integral part of a transformer or other power supply devices approved for the purpose.

725-36. Location of Overcurrent Devices. Overcurrent devices shall be located at the point where the conductor to be protected receives its supply.

725-37. Wiring Methods on Supply Side. Conductors and equipment on the supply side of overcurrent protection, transformers, or current-limiting devices shall be installed in accordance with the appropriate requirements of Chapter 3 of the NEC. Transformers or other devices supplied from light or power circuits shall be protected by an overcurrent device rated not over 20 amperes.

Exception: The input leads of a transformer or other power source supplying Class 2 and Class 3 circuits shall be permitted to be smaller than No. 14, but not smaller than No. 18 if they are not over 12 inches long and if they have insulation that complies with Section 725-16(b).

725-38. Wiring Methods on Load Side. Conductors on the load side of overcurrent protection, transformers, and current-limiting devices shall be insulated at not less than the requirements of Section 725-40 and shall comply with (a) below.

(a) Separation from Light, Power, and Class 1 Conductors.

(1) Open Conductors. Conductors of Class 2 and Class 3 circuits shall be separated at least 2 inches from conductors of any light, power, or Class 1 circuits.

Exception No. 1: Where the light or power, and Class 1 circuit conductors are in a raceway or in metal-sheathed, metal-clad, nonmetallic-sheathed, or Type UF cables.

Exception No. 2: Where the conductors are permanently separated from the conductors of the other circuits by a continuous and firmly fixed nonconductor, such as porcelain tubes or flexible tubing in addition to the insulation on the wire.

(2) In Enclosures, Raceways, Cable Trays, and Cables. Conductors of Class 2 and Class 3 circuits shall not be placed in any enclosure, raceway, cable tray, cable, compartment, outlet box, or similar fitting with conductors of light, power, and Class 1 circuits.

Exception No. 1: Where the conductors of the different circuits are separated by a partition.

Exception No. 2: Conductors in outlet boxes, junction boxes, or similar fittings, or compartments where power-supply conductors are introduced