operating at not over 150 volts between any two conductors or over 150 volts between any conductor and ground.

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

250.140 Frames of Ranges and Clothes Dryers

Frames of electric ranges, wall-mounted ovens, counter-mounted cooking units, clothes dryers, and outlet or junction boxes that are part of the circuit for these appliances shall be grounded in the manner specified by 250.134 or 250.138.

Exception: For existing branch circuit installations only where an equipment grounding conductor is not present in the outlet or junction box, the frames of electric ranges, wall-mounted ovens, counter-mounted cooking units, clothes dryers, and outlet or junction boxes that are part of the circuit for these appliances shall be permitted to be grounded to the grounded circuit conductor if all the following conditions are met.

(1) The supply circuit is 120/240-volt, single-phase, 3-wire; or 208Y/120-volt derived from a 3-phase, 4-wire, wye-connected system.
(2) The grounded conductor is not smaller than 10 AWG copper or 8 AWG aluminum.
(3) The grounded conductor is insulated, or the grounded conductor is uninsulated and part of a Type SE service-entrance cable and the branch circuit originates at the service equipment.
(4) Grounding contacts of receptacles furnished as part of the equipment are bonded to the equipment.

The exception to 250.140 applies only to existing branch circuits supplying the appliances specified in 250.140. The grounded conductor (neutral) of newly installed branch circuits supplying ranges and clothes dryers is no longer permitted to be used for grounding the non–current-carrying metal parts of the appliances. Branch circuits installed for new appliance installations are required to provide an equipment grounding conductor sized in accordance with 250.122 for grounding the non–current-carrying metal parts.

Caution should be exercised to ensure that new appliances connected to an existing branch circuit are properly grounded. An older appliance connected to a new branch circuit must have its 3-wire cord and plug replaced with a 4-conductor cord, with one of those conductors being an equipment grounding conductor. The bonding jumper between the neutral and the frame of the appliance must be removed. Where a new range or clothes dryer is connected to an existing branch circuit without an equipment grounding conductor, in which the neutral conductor is used for grounding the appliance frame, it must be ensured that a bonding jumper is in place between the neutral terminal of the appliance and the frame of the appliance.

The grounded circuit conductor of an existing branch circuit is still permitted to be used to ground the frame of an electric range, wall-mounted oven, or counter-mounted cooking unit, provided all four conditions of 250.140 Exception, are met. In addition, a revision in this provision for the 2005 *Code* permits application of the exception only where the existing branch-circuit wiring method does not provide an equipment grounding conductor. There are many existing branch circuits in which nonmetallic sheathed cable with three insulated circuit conductors and a bare equipment grounding conductor was used to supply a range or clothes dryer. The bare equipment grounding conductor was simply not used because it was permitted to ground the equipment with the insulated neutral conductor of the NM cable. The "extra" conductor was on account of the fact that the bare conductor in a Type NM cable is to be used only as an equipment grounding conductor and cannot be used as a grounded (neutral) conductor in the same manner as is permitted for an uninsulated conductor in the service entrance.

In addition to grounding the frame of the range or clothes dryer, the grounded circuit conductor of these existing branch circuits is also permitted to be used to ground any junction boxes in the circuit supplying the appliance, and a 3-wire pigtail and range receptacle are permitted to be used.

Prior to the 1996 *Code*, use of the grounded circuit conductor as a grounding conductor was permitted for all installations. In many instances, the wiring method was service-entrance cable with an uninsulated neutral conductor covered by the cable jacket. Where Type SE cable was used to supply ranges and dryers, the branch circuit was required to originate at the service equipment to avoid neutral current from downstream panelboards on metal objects, such as pipes or ducts.

Exhibit 250.51 shows an existing installation in which Type SE service-entrance cable was used for ranges, dryers, wall-mounted ovens, and counter-mounted cooking units. Junction boxes in the supply circuit were also permitted to be grounded from the grounded neutral conductor.

250.142 Use of Grounded Circuit Conductor for Grounding Equipment

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

(1) On the supply side or within the enclosure of the service-disconnecting means
(2) On the supply side or within the enclosure of the main disconnecting means for separate buildings as provided in 250.32(B)

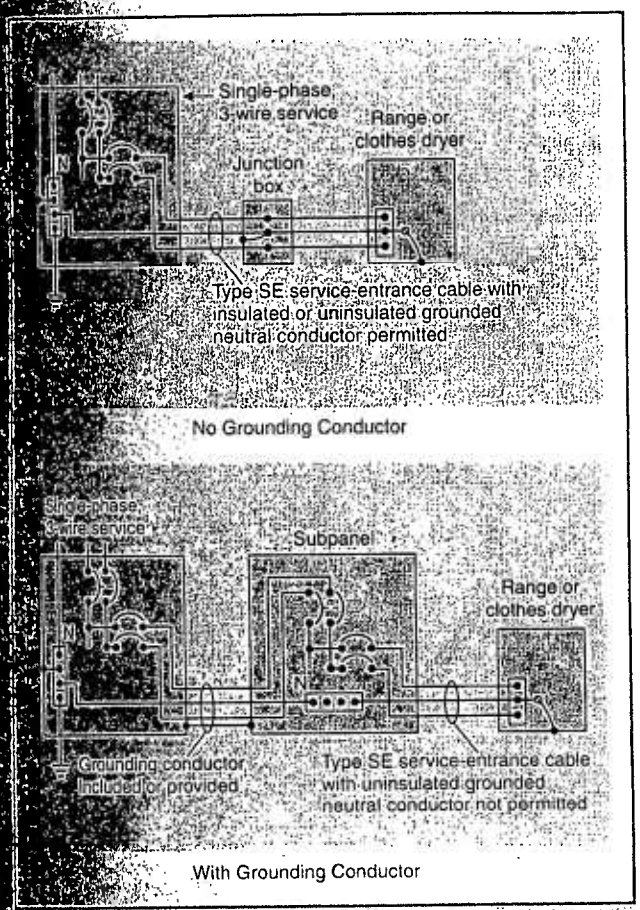


Exhibit 250.51 An existing installation in which the grounded conductor in Type SE service-entrance cable was used for grounding the frames of ranges and clothes dryers, plus associated metal junction boxes, in accordance with 250.140.

(3) On the supply side or within the enclosure of the main disconnecting means or overcurrent devices of a separately derived system where permitted by 250.30(A)(1)

In separately derived systems, the grounded circuit conductor is permitted to ground non–current-carrying metal parts of equipment, raceways, and other enclosures only on the supply side of the main disconnecting means.

(B) Load-Side Equipment Except as permitted in 250.30(A)(1) and 250.32(B), a grounded circuit conductor shall not be used for grounding non–current-carrying metal parts of equipment on the load side of the service disconnecting means or on the load side of a separately derived system disconnecting means or the overcurrent devices for a separately derived system not having a main disconnecting means.

Exception No. 1: The frames of ranges, wall-mounted ovens, counter-mounted cooking units, and clothes dryers under the conditions permitted for existing installations by 250.140 shall be permitted to be grounded by a grounded circuit conductor.

Exception No. 2: It shall be permissible to ground meter enclosures by connection to the grounded circuit conductor on the load side of the service disconnect where all of the following conditions apply:

(1) No service ground-fault protection is installed.
(2) All meter socket enclosures are located immediately adjacent to the service disconnecting means.
(3) The size of the grounded circuit conductor is not smaller than the size specified in Table 250.122 for equipment grounding conductors.

Exception No. 3: Direct-current systems shall be permitted to be grounded on the load side of the disconnecting means or overcurrent device in accordance with 250.164.

Exception No. 4: Electrode-type boilers operating at over 600 volts shall be grounded as required in 490.72(E)(1) and 490.74.

One major reason the grounded circuit conductor is not permitted to be grounded on the load side of the service [except as permitted in 250.30, 250.32(B)(2), and the four exceptions to 250.142(B)] is that, should the grounded service conductor become disconnected at any point on the line side of the ground, the equipment grounding conductor and all conductive parts connected to it would carry the neutral current, raising the potential to ground of exposed metal parts not normally intended to carry current. This could result in arcing in concealed spaces and could pose a severe shock hazard, particularly if the path is inadvertently opened by a person servicing or repairing piping or ductwork. Even without an open grounded conductor (usually referred to as an open neutral), the equipment grounding conductor path would become a parallel path with the grounded conductor, and there would be some potential drop on exposed and concealed dead metal parts. The magnitude of this potential difference would be determined by the relative impedances of the equipment grounding path and the grounded conductor circuits. Not only would the equipment grounding conductor path be affected, but all parallel paths not intended as equipment grounding conductors would be affected as well. This could involve current through metal building structures, piping, and ducts. The requirements of 250.30 and 250.32(B) have been revised in recent editions of the *Code* to prohibit the creation of parallel paths for normal neutral current.

250.144 Multiple Circuit Connections

Where equipment is required to be grounded and is supplied by separate connection to more than one circuit or grounded premises wiring system, a means for grounding shall be

provided for each such connection as specified in 250.134 and 250.138.

250.146 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 unless grounded as in 250.146(A) through (D).

(A) Surface Mounted Box Where the box is mounted on the surface, direct metal-to-metal contact between the device yoke and the box or a contact yoke or device that complies with 250.146(B) shall be permitted to ground the receptacle to the box. At least one of the insulating washers shall be removed from receptacles that do not have a contact yoke or device that complies with 250.146(B) to ensure direct metal-to-metal contact. This provision shall not apply to cover-mounted receptacles unless the box and cover combination are listed as providing satisfactory ground continuity between the box and the receptacle.

The main rule of 250.146 requires an equipment bonding jumper to be installed between the device box and the receptacle grounding terminal. However, 250.146(A) permits the equipment bonding jumper to be omitted where the metal yoke of the device is in direct metal-to-metal contact with the metal device box and at least one of the fiber retention washers for the receptacle mounting screws is removed, as illustrated in Exhibit 250.52.

Cover-mounted wiring devices, such as on 4-in. square covers, are not considered grounded. Section 250.146(A) does not apply to cover-mounted receptacles, such as the one illustrated in Exhibit 250.53. Box-cover and device combinations listed as providing grounding continuity are permitted.

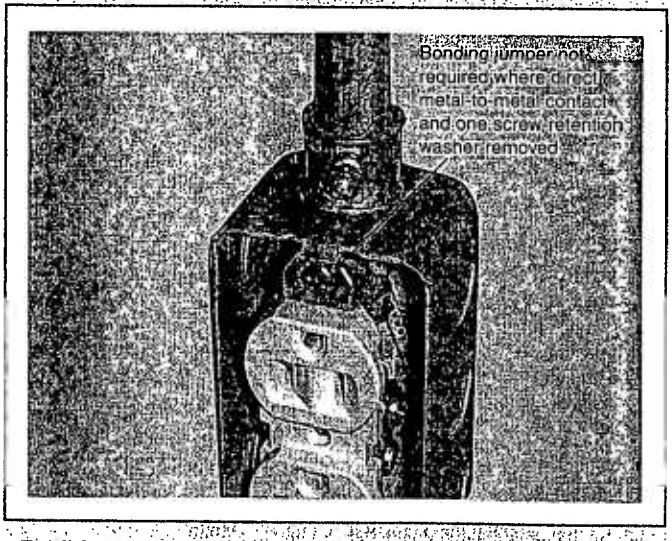


Exhibit 250.52 An example of a box-mounted receptacle attached to a surface box where a bonding jumper is not required provided at least one of the insulating washers is removed.

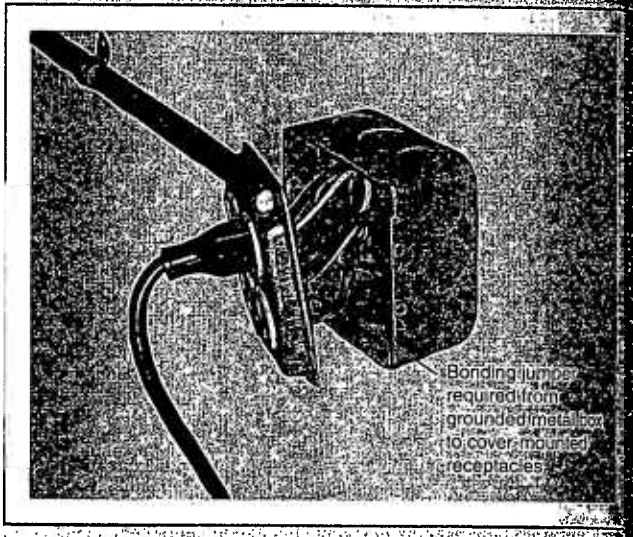


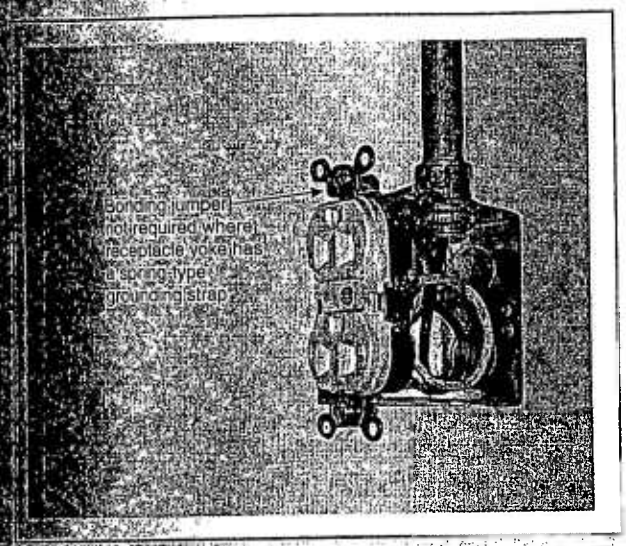
Exhibit 250.53 An example of a cover-mounted receptacle attached to a surface box where a bonding jumper is required.

(B) Contact Devices or Yokes Contact devices or yokes designed and listed as self-grounding shall be permitted in conjunction with the supporting screws to establish the grounding circuit between the device yoke and flush-type boxes.

Section 250.146(B) is illustrated by Exhibit 250.54, which shows a receptacle designed with a spring-type grounding strap for holding the mounting screw and establishing the grounding circuit so that an equipment bonding jumper is not required. Such devices are listed as "self-grounding."

(C) Floor Boxes Floor boxes designed for and listed as providing satisfactory ground continuity between the box and the device shall be permitted.

(D) Isolated Receptacles Where required for the reduction of electrical noise (electromagnetic interference) on the grounding circuit, a receptacle in which the grounding terminal is purposely insulated from the receptacle mounting means shall be permitted. The receptacle grounding terminal shall be grounded by an insulated equipment grounding conductor run with the circuit conductors. This grounding conductor shall be permitted to pass through one or more panelboards without connection to the panelboard grounding terminal as permitted in 408.40, Exception, so as to terminate within the same building or structure directly at an equipment



250.54 A receptacle designed with a listed spring-type grounding strap. The strap that holds the mounting screw captive provides a grounding circuit and eliminates the need to provide a separate equipment bonding jumper to the box, in accordance with 250.146(B).

grounding conductor terminal of the applicable derived system or service.

Use of an isolated equipment grounding conductor does not relieve the requirement for grounding the raceway system and outlet box.

Section 250.146(D) allows an isolated-ground–type receptacle to be installed without a bonding jumper between the metal device box and the receptacle grounding terminal. An insulated equipment grounding conductor, as shown in Exhibit 250.55, is installed with the branch-circuit conductors. This conductor may originate in the service panel, pass through any number of subpanels without being connected to the equipment grounding bus, and terminate at the isolated-ground-type receptacle ground terminal. However, this does not exempt the metal device box from being grounded. The metal device box must be grounded either by an equipment grounding conductor run with the circuit conductors or by a wiring method that serves as an equipment grounding conductor. See 250.118 for types of equipment grounding conductors.

According to 250.146(D), where isolated-ground–type receptacles are used, the isolated equipment grounding conductor can terminate at an equipment grounding terminal of the applicable service or derived system in the same building as the receptacle. If the isolated equipment grounding conductor terminates at a separate building, a large voltage difference may exist between buildings during lightning transients. Such transients could cause damage to equipment connected to an isolated-ground–type receptacle and present

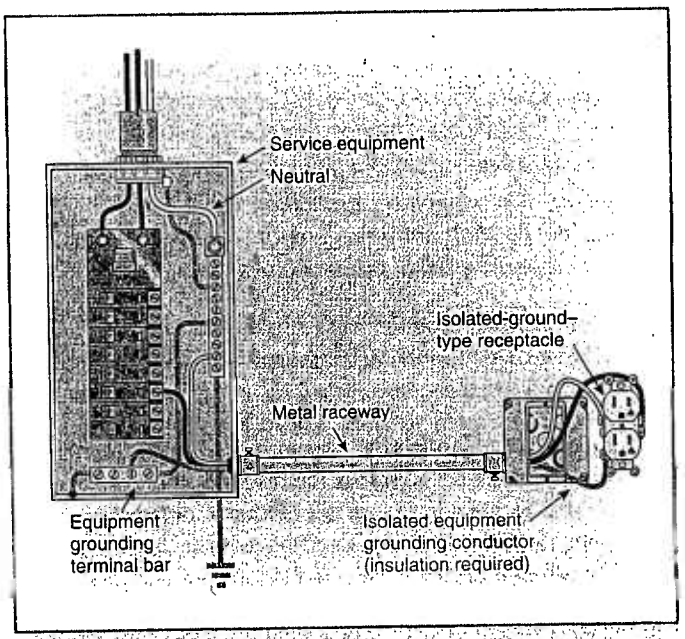


Exhibit 250.55 An isolated-ground–type receptacle with an insulated equipment grounding conductor and with the device box grounded through the metal raceway.

a shock hazard between the isolated equipment frame and other grounded surfaces.

The fine print note to 250.146(D) is a reminder that metallic raceways and boxes are still required to be grounded by one of the usual required methods. This could require a separate grounding conductor, for example, to ground a metal box in a nonmetallic raceway system or to ground a metal box supplied by flexible metal conduit. Where an ordinary grounding-type receptacle is being replaced with an isolated-ground–type receptacle, use of an existing insulated equipment grounding conductor as the isolated receptacle grounding conductor could effectively defeat or seriously compromise the required box or raceway equipment ground.

250.148 Continuity and Attachment of Equipment Grounding Conductors to Boxes

Where circuit conductors are spliced within a box, or terminated on equipment within or supported by a box, any equipment grounding conductor(s) associated with those circuit conductors shall be spliced or joined within the box or to the box with devices suitable for the use in accordance with 250.148(A) through (E).

Where a metal box is used in a metal raceway system and there is a wire-type equipment grounding conductor installed in the raceway, it is not required that the wire-type equipment grounding conductor be connected to the pull box provided the box is effectively grounded by the metal raceway and

the circuit conductors are not spliced or terminated to equipment in the metal box. An example of this provision would be where conductors are run unbroken through a pull box.

Exception: The equipment grounding conductor permitted in 250.146(D) shall not be required to be connected to the other equipment grounding conductors or to the box.

(A) Connections Connections and splices shall be made in accordance with 110.14(B) except that insulation shall not be required.

(B) Grounding Continuity The arrangement of grounding connections shall be such that the disconnection or the removal of a receptacle, luminaire (fixture), or other device fed from the box does not interfere with or interrupt the grounding continuity.

(C) 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 that shall be used for no other purpose or a listed grounding device.

(D) Nonmetallic Boxes One or more equipment grounding conductors brought into a nonmetallic outlet box shall be arranged such that a connection can be made to any fitting or device in that box requiring grounding.

(E) Solder Connections depending solely on solder shall not be used.

VIII. Direct-Current Systems

250.160 General

Direct-current systems shall comply with Part VIII and other sections of Article 250 not specifically intended for ac systems.

250.162 Direct-Current Circuits and Systems to Be Grounded

Direct-current circuits and systems shall be grounded as provided for in 250.162(A) and (B).

(A) Two-Wire, Direct-Current Systems A 2-wire, dc system supplying premises wiring and operating at greater than 50 volts but not greater than 300 volts shall be grounded.

Exception No. 1: A system equipped with a ground detector and supplying only industrial equipment in limited areas shall not be required to be grounded.

Exception No. 2: A rectifier-derived dc system supplied from an ac system complying with 250.20 shall not be required to be grounded.

Exception No. 3: Direct-current fire alarm circuits having a maximum current of 0.030 amperes as specified in Article 760, Part III, shall not be required to be grounded.

(B) Three-Wire, Direct-Current Systems The neutral conductor of all 3-wire, dc systems supplying premises wiring shall be grounded.

250.164 Point of Connection for Direct-Current Systems

(A) Off-Premises Source Direct-current systems to be grounded and supplied from an off-premises source shall have the grounding connection made at one or more supply stations. A grounding connection shall not be made at individual services or at any point on the premises wiring.

As shown in the 3-wire dc distribution system in Exhibit 250.56, the neutral is grounded at the off-premises generator site. Grounding of a 2-wire dc system would be accomplished in the same manner. For an on-premises generator, a grounding connection is required and is to be located at the source of the first system disconnecting means or overcurrent device. Other equivalent means that use equipment listed and identified for such use are permitted.

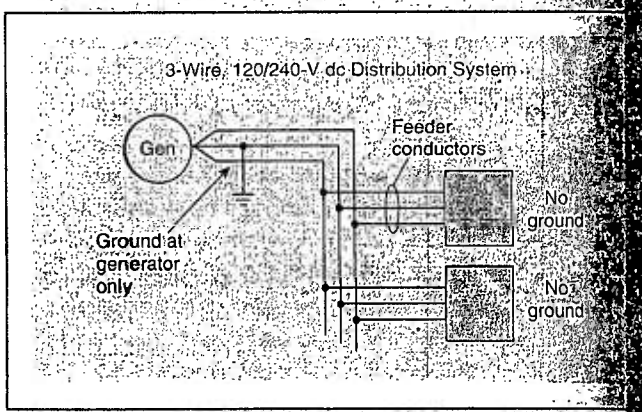


Exhibit 250.56 A 3-wire, 120/240-volt dc distribution system with the neutral grounded at the off-premises generator site.

(B) On-Premises Source Where the dc system source is located on the premises, a grounding connection shall be made at one of the following:

(1) The source
(2) The first system disconnection means or overcurrent device
(3) By other means that accomplish equivalent system protection and that utilize equipment listed and identified for the use

250.166 Size of Direct-Current Grounding Electrode Conductor

The size of the grounding electrode conductor for a dc system shall be as specified in 250.166(A) through (E).

(A) Not Smaller Than the Neutral Conductor Where the dc system consists of a 3-wire balancer set or a balancer winding with overcurrent protection as provided in 445.12(D), the grounding electrode conductor shall not be smaller than the neutral conductor and not smaller than 8 AWG copper or 6 AWG aluminum.

(B) Not Smaller Than the Largest Conductor Where the dc system is other than as in 250.166(A), the grounding electrode conductor shall not be smaller than the largest conductor supplied by the system, and not smaller than 8 AWG copper or 6 AWG aluminum.

(C) Connected to Rod, Pipe, or Plate Electrodes Where connected to rod, pipe, or plate electrodes as in 250.52(A)(5) or 250.52(A)(6), that portion of the grounding electrode conductor that is the sole connection to the grounding electrode shall not be required to be larger than 6 AWG copper wire or 4 AWG aluminum wire.

(D) Connected to a Concrete-Encased Electrode Where connected to a concrete-encased electrode as in 250.52(A)(3), that portion of the grounding electrode conductor that is the sole connection to the grounding electrode shall not be required to be larger than 4 AWG copper wire.

(E) Connected to a Ground Ring Where connected to a ground ring as in 250.52(A)(4), that portion of the grounding electrode conductor that is the sole connection to the grounding electrode shall not be required to be larger than the conductor used for the ground ring.

250.168 Direct-Current Bonding Jumper

For dc systems, the size of the bonding jumper shall not be smaller than the system grounding electrode conductor specified in 250.166.

250.169 Ungrounded Direct-Current Separately Derived Systems

Except as otherwise permitted in 250.34 for portable and vehicle-mounted generators, an ungrounded dc separately derived system supplied from a stand-alone power source (such as an engine–generator set) shall have a grounding electrode conductor connected to an electrode that complies with Part III to provide for grounding of metal enclosures, raceways, cables, and exposed non–current-carrying metal parts of equipment. The grounding electrode conductor connection shall be to the metal enclosure at any point on the separately derived system from the source to the first system disconnecting means or overcurrent device, or it shall be made at the source of a separately derived system that has no disconnecting means or overcurrent devices.

The size of the grounding electrode conductor shall be in accordance with 250.166.

IX. Instruments, Meters, and Relays

250.170 Instrument Transformer Circuits

Secondary circuits of current and potential instrument transformers shall be grounded where the primary windings are connected to circuits of 300 volts or more to ground and, where on switchboards, shall be grounded irrespective of voltage.

Exception: Circuits where the primary windings are connected to circuits of less than 1000 volts with no live parts or wiring exposed or accessible to other than qualified persons.

250.172 Instrument Transformer Cases

Cases or frames of instrument transformers shall be grounded where accessible to other than qualified persons.

Exception: Cases or frames of current transformers, the primaries of which are not over 150 volts to ground and that are used exclusively to supply current to meters.

250.174 Cases of Instruments, Meters, and Relays Operating at Less Than 1000 Volts

Instruments, meters, and relays operating with windings or working parts at less than 1000 volts shall be grounded as specified in 250.174(A), (B), or (C).

(A) Not on Switchboards Instruments, meters, and relays not located on switchboards, operating with windings or working parts at 300 volts or more to ground, and accessible to other than qualified persons, shall have the cases and other exposed metal parts grounded.

(B) On Dead-Front Switchboards Instruments, meters, and relays (whether operated from current and potential transformers or connected directly in the circuit) on switchboards having no live parts on the front of the panels shall have the cases grounded.

(C) On Live-Front Switchboards Instruments, meters, and relays (whether operated from current and potential transformers or connected directly in the circuit) on switchboards having exposed live parts on the front of panels shall not have their cases grounded. Mats of insulating rubber or other suitable floor insulation shall be provided for the operator where the voltage to ground exceeds 150.

250.176 Cases of Instruments, Meters, and Relays — Operating Voltage 1 kV and Over

Where instruments, meters, and relays have current-carrying parts of 1 kV and over to ground, they shall be isolated by elevation or protected by suitable barriers, grounded metal, or insulating covers or guards. Their cases shall not be grounded.

Exception: Cases of electrostatic ground detectors where the internal ground segments of the instrument are connected to the instrument case and grounded and the ground detector is isolated by elevation.

250.178 Instrument Grounding Conductor

The grounding conductor for secondary circuits of instrument transformers and for instrument cases shall not be smaller than 12 AWG copper or 10 AWG aluminum. Cases of instrument transformers, instruments, meters, and relays that are mounted directly on grounded metal surfaces of enclosures or grounded metal switchboard panels shall be considered to be grounded, and no additional grounding conductor shall be required.

X. Grounding of Systems and Circuits of 1 kV and Over (High Voltage)

250.180 General

Where high-voltage systems are grounded, they shall comply with all applicable provisions of the preceding sections of this article and with 250.182 through 250.190, which supplement and modify the preceding sections.

250.182 Derived Neutral Systems

A system neutral derived from a grounding transformer shall be permitted to be used for grounding high-voltage systems.

250.184 Solidly Grounded Neutral Systems

Solidly grounded neutral systems shall be permitted to be either single point grounded or multigrounded neutral.

For systems over 1000 volts, the *Code* permits solidly grounded neutral systems that are either single-point grounded or multigrounded systems. For the 2005 *Code*, 250.184 was reorganized, and new requirements for the installation of single-point grounded systems were added. Circuits supplied from a single-point grounded system are required to have an equipment grounding conductor run with the circuit conductors, and this conductor is not to be used as a conductor for continuous line-to-neutral load.

(A) Neutral Conductor

(1) Insulation Level The minimum insulation level for neutral conductors of solidly grounded systems shall be 600 volts.

Exception No. 1: Bare copper conductors shall be permitted to be used for the neutral of service entrances and the neutral of direct-buried portions of feeders.

Exception No. 2: Bare conductors shall be permitted for the neutral of overhead portions installed outdoors.

Exception No. 3: The neutral grounded conductor shall be permitted to be a bare conductor if isolated from phase conductors and protected from physical damage.

FPN: See 225.4 for conductor covering where within 3.0 m (10 ft) of any building or other structure.

(2) Ampacity The neutral conductor shall be of sufficient ampacity for the load imposed on the conductor but not less than 33⅓ percent of the ampacity of the phase conductor.

Exception: In industrial and commercial premises under engineering supervision, it shall be permissible to size the ampacity of the neutral conductor to not less than 20 percent of the ampacity of the phase conductor.

(B) Single Point Grounded System Where a single point grounded neutral system is used, the following shall apply:

(1) A single point grounded system shall be permitted to be supplied from (a) or (b):
   a. A separately derived system
   b. A multigrounded neutral system with an equipment grounding conductor connected to the multigrounded neutral at the source of the single point grounded system

(2) A grounding electrode shall be provided for the system.

(3) A grounding electrode conductor shall connect the grounding electrode to the system neutral.

(4) A bonding jumper shall connect the equipment grounding conductor to the grounding electrode conductor.

(5) An equipment bonding conductor shall be provided for each building, structure, and equipment enclosure.

(6) A neutral shall only be required where phase to neutral loads are supplied.

(7) The neutral, where provided, shall be insulated and isolated from earth except at one location.

(8) An equipment grounding conductor shall be run with the phase conductors and shall comply with (a), (b), and (c):
   a. Shall not carry continuous load
   b. May be bare or insulated
   c. Shall have sufficient ampacity for fault current duty

(C) Multigrounded Neutral Systems Where a multigrounded neutral system is used, the following shall apply:

(1) The neutral of a solidly grounded neutral system shall be permitted to be grounded at more than one point. Grounding shall be permitted at one or more of the following locations:

a. Transformers supplying conductors to a building or other structure
b. Underground circuits where the neutral is exposed
c. Overhead circuits installed outdoors

(2) The multigrounded neutral conductor shall be grounded at each transformer and at other additional locations by connection to a made or existing electrode.
(3) At least one grounding electrode shall be installed and connected to the multigrounded neutral circuit conductor every 400 m (1300 ft).
(4) The maximum distance between any two adjacent electrodes shall not be more than 400 m (1300 ft).
(5) In a multigrounded shielded cable system, the shielding shall be grounded at each cable joint that is exposed to personnel contact.

250.186 Impedance Grounded Neutral Systems

Impedance grounded neutral systems in which a grounding impedance, usually a resistor, limits the ground-fault current, shall be permitted where all of the following conditions are met.

(1) The conditions of maintenance and supervision ensure that only qualified persons will service the installation.
(2) Ground detectors are installed on the system.
(3) Line-to-neutral loads are not served.

Impedance grounded neutral systems shall comply with the provisions of 250.186(A) through (D).

(A) Location The grounding impedance shall be inserted in the grounding conductor between the grounding electrode of the supply system and the neutral point of the supply transformer or generator.

(B) Identified and Insulated The neutral conductor of an impedance grounded neutral system shall be identified, as well as fully insulated with the same insulation as the phase conductors.

(C) System Neutral Connection The system neutral shall not be connected to ground, except through the neutral grounding impedance.

(D) Equipment Grounding Conductors Equipment grounding conductors shall be permitted to be bare and shall be electrically connected to the ground bus and grounding electrode conductor.

250.188 Grounding of Systems Supplying Portable or Mobile Equipment

Systems supplying portable or mobile high-voltage equipment, other than substations installed on a temporary basis, shall comply with 250.188(A) through (F).

Portable describes equipment that is easily carried from one location to another. *Mobile* describes equipment that is easily moved on wheels, treads, and so on.

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

(B) Exposed Non–Current-Carrying Metal Parts Exposed non–current-carrying metal parts of portable or mobile equipment shall be connected by an equipment grounding conductor to the point at which the system neutral impedance is grounded.

(C) Ground-Fault Current The voltage developed between the portable or mobile equipment frame and ground by the flow of maximum ground-fault current shall not exceed 100 volts.

(D) Ground-Fault Detection and Relaying Ground-fault detection and relaying shall be provided to automatically de-energize any high-voltage system component that has developed a ground fault. The continuity of the equipment grounding conductor shall be continuously monitored so as to de-energize automatically the high-voltage circuit to the portable or mobile equipment upon loss of continuity of the equipment grounding conductor.

(E) Isolation The grounding electrode to which the portable or mobile equipment system neutral impedance is connected shall be isolated from and separated in the ground by at least 6.0 m (20 ft) from any other system or equipment grounding electrode, and there shall be no direct connection between the grounding electrodes, such as buried pipe and fence, and so forth.

(F) Trailing Cable and Couplers High-voltage trailing cable and couplers for interconnection of portable or mobile equipment shall meet the requirements of Part III of Article 400 for cables and 490.55 for couplers.

250.190 Grounding of Equipment

All non–current-carrying metal parts of fixed, portable, and mobile equipment and associated fences, housings, enclosures, and supporting structures shall be grounded.

Exception: Where isolated from ground and located so as to prevent any person who can make contact with ground from contacting such metal parts when the equipment is energized.

Grounding conductors not an integral part of a cable assembly shall not be smaller than 6 AWG copper or 4 AWG aluminum.

Type CMX
Type CMUC Undercarpet Wire and Cable
Multipurpose (MP) Cables
Communications Circuit Integrity (CI) Cable
Wires
Hybrid Power and Communications Cable
Communications Raceways
Plenum Communications Raceways
Riser Communications Raceways
General-Purpose Communications Raceways

Rules that are followed by a reference in brackets [ ] that has been extracted from NFPA 97–2003, *Glossary of Terms Relating to Chimneys, Vents, and Heat-Producing Appliances*. Only editorial changes were made to the extracted text to make it consistent with this *Code*.

...terial

...Scope

...vers telephone, telegraph (except radio), outside ... fire alarm and burglar alarm, and similar ...ation systems; and telephone systems not connected ...ntral station system but using similar types of equipment, methods of installation, and maintenance.

...ion 90.3, Code Arrangement, states that Chapter 8, ...h comprises Articles 800, 810, 820, and 830, covers communications systems and is not subject to the requirements of Chapters 1–7 except where a requirement from those chapters is specifically referenced in Chapter 8. For instance, 800.44(A)(3) references 225.14(D), 800.90(C) references Article 500, and 800.3(D) references 300.22(C).

Although information technology equipment systems are often used for or with communications systems, Article 800 does not cover wiring of this equipment. Instead, Article 645 provides requirements for wiring contained solely within the information technology equipment (computer) room. (See 645.2 for a description of the type of information technology equipment room to which Article 645 applies.) Article 725 provides requirements for wiring that extends beyond a computer room and also covers wiring of local area networks in buildings. Article 760 covers wiring requirements for fire alarm systems.

In some cases, telephone system wiring is also used for data transmission; this use is covered by Article 800. Telephone company central offices are exempt from the requirements of Article 800 by 90.2(B)(4). The format of Article 800 is similar to that of Articles 725, 760, 770, and 820. Article 830 covers network-powered broadband communications systems.

FPN No. 1: For further information for fire alarm, sprinkler waterflow, and sprinkler supervisory systems, see Article 760.

FPN No. 2: For installation requirements of optical fiber cables, see Article 770.

FPN No. 3: For installation requirements for network-powered broadband communications circuits, see Article 830.

800.2 Definitions

See Article 100. For purposes of this article, the following additional definitions apply.

Abandoned Communications Cable. Installed communications cable that is not terminated at both ends at a connector or other equipment and not identified for future use with a tag.

The term *abandoned communications cable* applies to 800.154, which requires removal of accessible abandoned communications cable. Abandoned cable increases fire loading unnecessarily, and, where installed in plenums, it can affect airflow. Similar requirements can be found in Articles 640, 645, 725, 760, 770, 820, and 830.

Air Duct. A conduit or passageway for conveying air to or from heating, cooling, air conditioning, or ventilating equipment, but not including the plenum. [NFPA 97:1.2.6]

The definition of *air duct* was added to the 2005 *Code* to provide a term to distinguish between electrical ducts and ducts that form part of an environmental air distribution system.

Block. A square or portion of a city, town, or village enclosed by streets and including the alleys so enclosed, but not any street.

Cable. A factory assembly of two or more conductors having an overall covering.

Cable Sheath. A covering over the conductor assembly that may include one or more metallic members, strength members, or jackets.

Communications Circuit Integrity (CI) Cable. Cable used in communications systems to ensure continued operation of critical circuits during a specified time under fire conditions.

The definition of *communications circuit integrity (CI) cable* was added to the 2005 *Code* to define a term used in 800.179(H). CI cables are used to maintain communications throughout the entire time of an emergency. Such cable

is intended to ensure the survivability of certain critical communications circuits during a fire in a building.

Communications Equipment. The electronic equipment that performs the telecommunications operations for the transmission of audio, video, and data, and including power equipment (e.g., dc converters, inverters and batteries) and technical support equipment (e.g., computers).

The definition of *communications equipment* was added to the 2005 *Code* to clearly define what associated equipment is considered part of the communications equipment. The definition clearly indicates that the power supplies and computers are considered part of the communications equipment and thus are subject to requirements that apply to communications equipment. The telephone switch shown in Exhibit 800.1 also is considered part of telecommunications equipment and so is subject to the same requirements. The definition correlates with NFPA 76, *Recommended Practice for the Fire Protection of Telecommunications Facilities.*

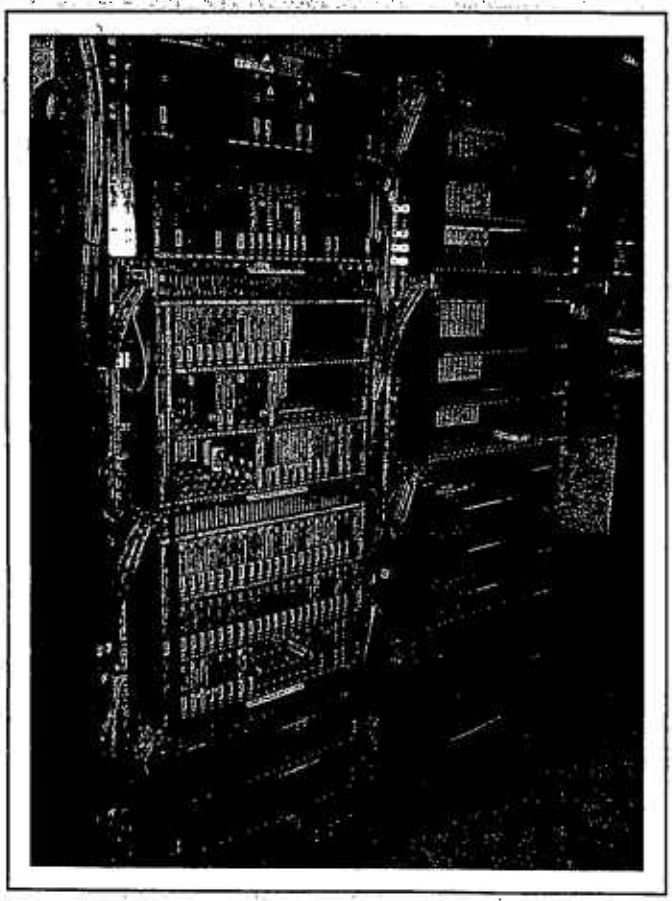


Exhibit 800.1 A private automatic branch exchange, one part of telecommunications equipment.

Exposed. A circuit that is in such a position that, in the event of failure of supports and insulation, contact with another circuit may result.

FPN: See Article 100 for two other definitions of *Exposed.*

Point of Entrance. Within a building, the point at which the wire or cable emerges from an external wall, floor, or concrete floor slab, or from a rigid metal conduit or intermediate metal conduit grounded to an electrode in accordance with 800.100(B).

Premises. The land and buildings of a user located on the user side of the utility-user network point of demarcation.

Wire. A factory assembly of one or more insulated conductors without an overall covering.

See Article 100 for the definitions of *conductor, communications* and *raceway.*

800.3 Other Articles

(A) Hybrid Power and Communications Cable. The provisions of 780.6 shall apply for listed hybrid power and communications cables in closed-loop and programmed power distribution.

See 800.179(J) for listing requirements and applications of hybrid power and communications cable in one- and two-family residences for other than closed-loop and programmed power distribution.

FPN: See 800.179(J) for hybrid power and communications cable in other applications.

(B) Hazardous (Classified) Locations. Communications circuits and equipment installed in a location that is classified in accordance with Article 500 shall comply with the applicable requirements of Chapter 5.

Paragraph 800.3(B) alerts users that communications circuits installed in locations classified in accordance with Article 500 must conform to the applicable requirements of Chapter 5.

(C) Spread of Fire or Products of Combustion. Section 300.21 shall apply. The accessible portion of abandoned communications cables shall not be permitted to exist.

Section 800.3(C) was revised for the 2005 *Code* to coordinate with the definition of *abandoned communications*

ection 800.3(C) requires the removal of accessible ed communications cable. Abandoned cable in- re loading unnecessarily, and, where installed in uns it can affect airflow. Similar requirements can be d in Articles 640, 645, 725, 760, 770, 820, and 830. he definition of *abandoned communications cable* in

uipment in Other Space Used for Environmental ection 300.22(C) shall apply.

8 Installation of Equipment

ment electrically connected to a telecommunications rk shall be listed in accordance with 800.170. Installa- equipment shall also comply with 110.3(B).

63, *Communication Circuit Accessories*, and UL 950, *Safety of Information Technology Equipment, Part 1: al Requirements*, are two safety standards that contain ements for determining whether equipment connected communications network is suitable for the intended ose. Listed equipment that is connected to the telecom- cations network and evaluated according to other U.S. ty standards is also subject to telecommunications re- ments appropriate for the equipment. Examples of this ment include information technology equipment, eo equipment, and signaling equipment connected ent al station. The appropriate requirements contained e applicable safety standard are extracted from UL 60950, or both.

xcept for test equipment, all permanently installed cable components of the communications network are to the listing requirements of 800.170.

tion: This listing requirement shall not apply to test ment that is intended for temporary connection to a mmunications network by qualified persons during the se of installation, maintenance, or repair of telecommu- tions equipment or systems.

21 Access to Electrical Equipment Behind nels Designed to Allow Access

s to electrical equipment shall not be denied by an mulation of wires and cables that prevents removal of nels, including suspended ceiling panels.

ss accumulation of wires and cables can limit access pment by preventing the removal of access panels. Exhibit 800.2.)

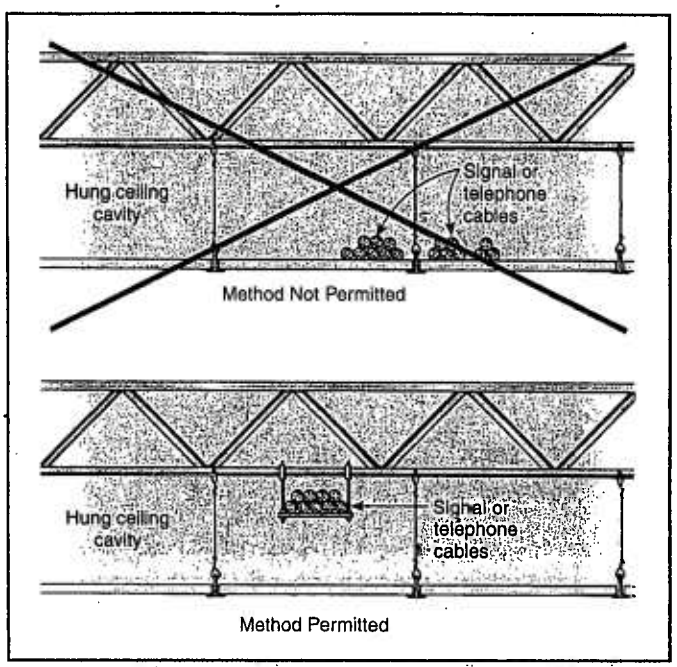


Exhibit 800.2 Installations of conductors and cables, which can prevent access to equipment or cables. Correct and incorrect methods are shown.

800.24 Mechanical Execution of Work

Communications circuits and equipment shall be installed in a neat and workmanlike manner. Cables installed exposed on the surface of ceilings and sidewalls shall be supported by the building structure in such a manner that the cable will not be damaged by normal building use. Such cables shall be secured by straps, staples, hangers, or similar fittings designed and installed so as not to damage the cable. The installation shall also conform with 300.4(D) and 300.11.

Section 800.24 provides definitive requirements for workmanship. Cable must be attached to or supported by the structure by straps, clamps, hangers, and the like. The installation method must not damage the cable. In addition, the location of the cable must be carefully evaluated to ensure that activities and processes within the building do not damage the cable. In the 2005 *Code*, there was a change to this section to permit attachment to baseboards and non-load bearing walls, which are not structural components. The equipment illustrated in Exhibit 800.3 is used by installers of telecommunications systems to organize cables and make connections in a neat and workmanlike manner.

FPN: Accepted industry practices are described in ANSI/NECA/BICSI 568-2001, *Standard for Installing Commercial Building Telecommunications Cabling*, and other ANSI-approved installation standards.

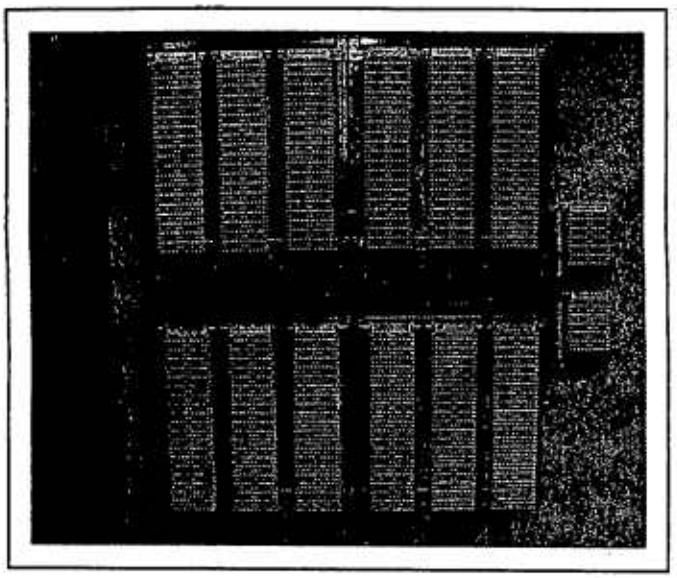


Exhibit 800.3 An example of punch blocks used on a private automatic branch exchange.

II. Wires and Cables Outside and Entering Buildings

800.44 Overhead Communications Wires and Cables

Overhead communications wires and cables entering buildings shall comply with 800.44(A) and 800.44(B).

(A) On Poles and In-Span Where communications wires and cables and electric light or power conductors are supported by the same pole or run parallel to each other in-span, the conditions described in 800.44(A)(1) through (A)(4) shall be met.

(1) Relative Location Where practicable, the communications wires and cables shall be located below the electric light or power conductors.

(2) Attachment to Crossarms Communications wires and cables shall not be attached to a cross-arm that carries electric light or power conductors.

(3) Climbing Space The climbing space through communications wires and cables shall comply with the requirements of 225.14(D).

(4) Clearance Supply service drops of 0–750 volts running above and parallel to communications service drops shall have a minimum separation of 300 mm (12 in.) at any point in the span, including the point of and at their attachment to the building, provided the nongrounded conductors are insulated and that a clearance of not less than 1.0 m (40 in.) is maintained between the two services at the pole.

(B) Above Roofs Communications wires and cables shall have a vertical clearance of not less than 2.5 m (8 ft) from all points of roofs above which they pass.

Exception No. 1: Auxiliary buildings, such as garages and the like.

Exception No. 2: A reduction in clearance above the overhanging portion of the roof to not less than 450 mm (18 in.) shall be permitted if (a) not more than 1.2 m (4 ft) of communications service-drop conductors pass above the roof overhang and (b) they are terminated at a through- or above-the-roof raceway or approved support.

Exception No. 3: Where the roof has a slope of not less than 100 mm in 300 mm (4 in. in 12 in.), a reduction in clearance to not less than 900 mm (3 ft) shall be permitted.

FPN: For additional information regarding overhead wires and cables, see ANSI C2-2002, *National Electrical Safety Code*, Part 2, Safety Rules for Overhead Lines.

800.47 Underground Circuits Entering Buildings

Underground communications wires and cables entering buildings shall comply with 800.47(A) and 800.47(B).

(A) With Electric Light or Power Conductors Underground communications wires and cables in a manhole, every handhole enclosure, or manhole containing electric light, power, Class 1, or non–power-limited fire alarm circuit conductors shall be in a section separated from such conductors by means of brick, concrete, or tile partitions or by means of a suitable barrier.

(B) Underground Block Distribution Where the continuous street circuit is run underground and the circuit within the block is placed so as to be free from the likelihood of accidental contact with electric light or power circuits of over 300 volts to ground, the insulation requirements of 800.50(A) and 800.50(C) shall not apply, insulating supports shall not be required for the conductors, and bushings shall not be required where the conductors enter the building.

800.50 Circuits Requiring Primary Protectors

Circuits that require primary protectors as provided in 800.40 shall comply with 800.50(A), (B), and (C).

(A) Insulation, Wires, and Cables Communications wires and cables without a metallic shield, running from the last outdoor support to the primary protector, shall be listed.

(B) On Buildings Communications wires and cables in accordance with 800.50(A) shall be separated at least 100 mm (4 in.) from electric light or power conductors not in raceway or cable or be permanently separated from conductors of the other system by a continuous and firmly fixed

nonconductor in addition to the insulation on the wires, such as porcelain tubes or flexible tubing. Communications wires and cables in accordance with 800.50(A) exposed to accidental contact with electric light and power conductors operating over 300 volts to ground and attached to buildings shall be separated from woodwork by being supported on glass, porcelain, or other insulating material.

Exception: Separation from woodwork shall not be required where fuses are omitted as provided for in 800.90(A)(1), or where conductors are used to extend circuits to a building from a cable having a grounded metal sheath.

(C) **Entering Buildings** Where a primary protector is installed inside the building, the communications wires and cables shall enter the building either through a noncombustible, nonabsorbent insulating bushing or through a metal raceway. The insulating bushing shall not be required where the entering communications wires and cables (1) are in metal-sheathed cable, (2) pass through masonry, (3) meet the requirements of 800.50(A) and fuses are omitted as provided in 800.90(A)(1), or (A)(4) meet the requirements of 800.50(A) and are used to extend circuits to a building from a cable having a grounded metallic sheath. Raceways or bushings shall slope upward from the outside or, where this cannot be done, drip loops shall be formed in the communications wires and cables immediately before they enter the building.

Raceways shall be equipped with an approved service head. More than one communications wire and cable shall be permitted to enter through a single raceway or bushing. Conduits or other metal raceways located ahead of the primary protector shall be grounded.

800.53 Lightning Conductors

Where practicable, a separation of at least 1.8 m (6 ft) shall be maintained between communications wires and cables on buildings and lightning conductors.

III. Protection

800.90 Protective Devices

(A) **Application** A listed primary protector shall be provided on each circuit run partly or entirely in aerial wire or aerial cable not confined within a block. Also, a listed primary protector shall be provided on each circuit, aerial or underground, located within the block containing the building served so as to be exposed to accidental contact with electric light or power conductors operating at over 300 volts to ground. In addition, where there exists a lightning exposure, each interbuilding circuit on a premises shall be protected by a listed primary protector at each end of the interbuilding circuit. Installation of primary protectors shall also comply with 110.3(B).

Telephone utility companies ordinarily provide primary protectors where telephone lines are exposed to lightning. Installers of private networks that include interbuilding cable should also install primary protectors where cables are exposed to lightning. Generally, cable is considered to be exposed to lightning unless one or more of the conditions in FPN No. 2 exist. A primary protector is required at each end of an interbuilding communications circuit where lightning exposure exists.

FPN No. 1: On a circuit not exposed to accidental contact with power conductors, providing a listed primary protector in accordance with this article helps protect against other hazards, such as lightning and above-normal voltages induced by fault currents on power circuits in proximity to the communications circuit.

FPN No. 2: Interbuilding circuits are considered to have a lightning exposure unless one or more of the following conditions exist:

(1) Circuits in large metropolitan areas where buildings are close together and sufficiently high to intercept lightning.
(2) Interbuilding cable runs of 42 m (140 ft) or less, directly buried or in underground conduit, where a continuous metallic cable shield or a continuous metallic conduit containing the cable is bonded to each building grounding electrode system.
(3) Areas having an average of five or fewer thunderstorm days per year and earth resistivity of less than 100 ohm-meters. Such areas are found along the Pacific coast.

(1) **Fuseless Primary Protectors** Fuseless-type primary protectors shall be permitted under any of the conditions given in (A)(1)(a) through (A)(1)(e).

(a) Where conductors enter a building through a cable with grounded metallic sheath member(s) and where the conductors in the cable safely fuse on all currents greater than the current-carrying capacity of the primary protector and of the primary protector grounding conductor

(b) Where insulated conductors in accordance with 800.50(A) are used to extend circuits to a building from a cable with an effectively grounded metallic sheath member(s) and where the conductors in the cable or cable stub, or the connections between the insulated conductors and the exposed plant, safely fuse on all currents greater than the current-carrying capacity of the primary protector, or the associated insulated conductors and of the primary protector grounding conductor

(c) Where insulated conductors in accordance with 800.50(A) or 800.50(B) are used to extend circuits to a building from other than a cable with metallic sheath member(s), where (1) the primary protector is listed as being suitable for this purpose for application with circuits extending from other than a cable with metallic sheath members, and (2) the connections of the insulated conductors to the ex-

posed plant or the conductors of the exposed plant safely fuse on all currents greater than the current-carrying capacity of the primary protector, or associated insulated conductors and of the primary protector grounding conductor

(d) Where insulated conductors in accordance with 800.50(A) are used to extend circuits aerially to a building from an unexposed buried or underground circuit

(e) Where insulated conductors in accordance with 800.50(A) are used to extend circuits to a building from cable with an effectively grounded metallic sheath member(s), and where (1) the combination of the primary protector and insulated conductors is listed as being suitable for this purpose for application with circuits extending from a cable with an effectively grounded metallic sheath member(s), and (2) the insulated conductors safely fuse on all currents greater than the current-carrying capacity of the primary protector and of the primary protector grounding conductor

The term *effectively grounded* (listed as *Grounded, Effectively*) is defined in Article 100.

(2) Fused Primary Protectors Where the requirements listed under 800.90(A)(1)(a) through (A)(1)(e) are not met, fused-type primary protectors shall be used. Fused-type primary protectors shall consist of an arrester connected between each line conductor and ground, a fuse in series with each line conductor, and an appropriate mounting arrangement. Primary protector terminals shall be marked to indicate line, instrument, and ground, as applicable.

(B) Location The primary protector shall be located in, on, or immediately adjacent to the structure or building served and as close as practicable to the point of entrance.

FPN: See 800.2 for the definition of *point of entrance*.

Exhibit 800.4 shows an example of a primary protector unit typically installed in commercial buildings. Exhibit 800.5 shows an example of applications of listed communications and multipurpose cable.

For purposes of this section, primary protectors located at mobile home service equipment located in sight from and not more than 9.0 m (30 ft) from the exterior wall of the mobile home it serves, or at a mobile home disconnecting means grounded in accordance with 250.32 and located in sight from and not more than 9.0 m (30 ft) from the exterior wall of the mobile home it serves, shall be considered to meet the requirements of this section.

FPN: Selecting a primary protector location to achieve the shortest practicable primary protector grounding conductor helps limit potential differences between communications circuits and other metallic systems.

(C) Hazardous (Classified) Locations The primary protector shall not be located in any hazardous (classified) location as defined in Article 500 or in the vicinity of ignitible material.

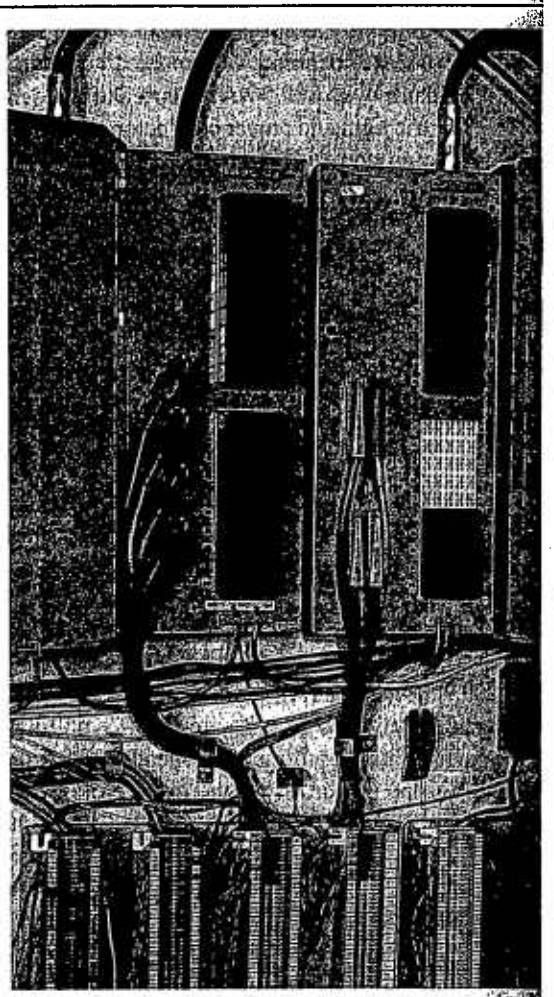


Exhibit 800.4 A primary protector unit typically installed in commercial buildings. This unit is the interface to the outside cable.

Exception: As permitted in 501.150, 502.150, and

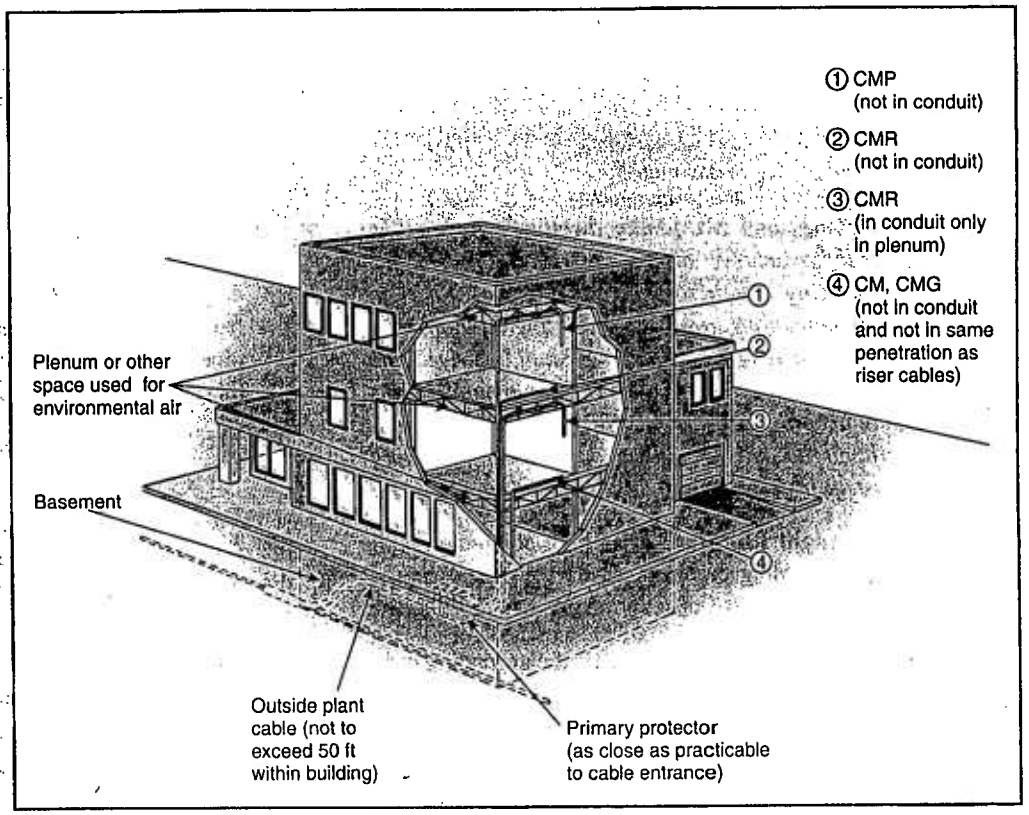
(D) Secondary Protectors Where a secondary protector is installed in series with the indoor communications wire/cable between the primary protector and the equipment, it shall be listed for the purpose in accordance with 800.

FPN: Secondary protectors on exposed circuits are intended for use without primary protectors.

800.93 Cable Grounding

The metallic sheath of communications cables entering buildings shall be grounded as close as practicable to the point of entrance or shall be interrupted as close to the point of entrance as practicable by an insulating joint or equivalent device.

FPN: See 800.2 for the definition of *point of entrance*.



t 800.5 An example of ...ations of listed communi... ...s cables.

Grounding Methods

800.100 Cable and Primary Protector Grounding

...e metallic member(s) of the cable sheath, where required to be grounded by 800.93, and primary protectors shall be ...unded as specified in 800.100(A) through 800.100(D).

(A) Grounding Conductor.

(1) **Insulation** The grounding conductor shall be insulated and shall be listed as suitable for the purpose.

(2) **Material** The grounding conductor shall be copper or ...her corrosion-resistant conductive material, stranded or ...id.

(3) **Size** The grounding conductor shall not be smaller than ...4 AWG.

(4) **Length** The primary protector grounding conductor ...all be as short as practicable. In one- and two-family ...ellings, the primary protector grounding conductor shall ...as short as practicable, not to exceed 6.0 m (20 ft) in ...ngth.

...or one- and two-family dwellings, 800.100(A)(4) restricts the length of the primary protector grounding conductor to 20 ft. This restricted conductor length reduces the impedance of the grounding conductor, resulting in a lower potential difference between the communications system conductors and equipment and the electrical conductors and equipment in the building. The low impedance bonding connection will reduce the fire hazard and shock hazard to persons in the event that electric utility power lines come in contact with communications conductors. Section 800.100(D) requires bonding of communications and power grounding electrodes at the same building or structure.

See the commentary following 250.52(A)(1) for information on water pipes as grounding electrodes.

> FPN: Similar grounding conductor length limitations applied at apartment buildings and commercial buildings help to reduce voltages that may be developed between the building's power and communications systems during lightning events.

When the 20-ft limitation was instituted in the 2002 *Code*, the predominant application was in one- and two-family dwellings; apartment and commercial buildings were specifically not addressed. In the 2005 *Code*, some guidance is provided for apartment and commercial buildings, without being overly restrictive because of intersystem bonding situations that may exist at these facilities. The FPN to 800.100(A)(4) provides guidance for the treatment of the cable and primary protector grounding conductor length at

apartment and commercial buildings that is consistent with the 20-ft rule for one- and two-family dwellings. However, a specific length is not specified in the *Code* because such a length limitation may not be practical in some installations.

Exception: In one- and two-family dwellings where it is not practicable to achieve an overall maximum primary protector grounding conductor length of 6.0 m (20 ft), a separate communications ground rod meeting the minimum dimensional criteria of 800.100(B)(2)(2) shall be driven, the primary protector shall be grounded to the communications ground rod in accordance with 800.100(C), and the communications ground rod shall be bonded to the power grounding electrode system in accordance with 800.100(D).

(5) Run in Straight Line The grounding conductor shall be run to the grounding electrode in as straight a line as practicable.

(6) Physical Damage Where necessary, the grounding conductor shall be guarded from physical damage. Where the grounding conductor is run in a metal raceway, both ends of the raceway shall be bonded to the grounding conductor or the same terminal or electrode to which the grounding conductor is connected.

(B) Electrode The grounding conductor shall be connected in accordance with 800.100(B)(1) and (B)(2).

(1) In Buildings or Structures with Grounding Means To the nearest accessible location on the following:

(1) The building or structure grounding electrode system as covered in 250.50
(2) The grounded interior metal water piping system, within 1.5 m (5 ft) from its point of entrance to the building, as covered in 250.52
(3) The power service accessible means external to enclosures as covered in 250.94
(4) The metallic power service raceway
(5) The service equipment enclosure
(6) The grounding electrode conductor or the grounding electrode conductor metal enclosure
(7) The grounding conductor or the grounding electrode of a building or structure disconnecting means that is grounded to an electrode as covered in 250.32

For purposes of this section, the mobile home service equipment or the mobile home disconnecting means, as described in 800.90(B), shall be considered accessible.

(2) In Buildings or Structures Without Grounding Means If the building or structure served has no grounding means, as described in 800.100(B)(1), the grounding conductor shall be connected to either of the following:

(1) To any one of the individual electrodes described in 250.52(A)(1), (A)(2), (A)(3), or (A)(4)
(2) If the building or structure served has no grounding means, as described in 800.100(B)(1) or (B)(2)(1), to an effectively grounded metal structure or to a ground rod or pipe not less than 1.5 m (5 ft) in length and 12.7 mm (½ in.) in diameter, driven, where practicable, into permanently damp earth and separated from lightning conductors as covered in 800.53 and at least 1.8 m (6 ft) from electrodes of other systems. Steam or hot water pipes or air terminal conductors (lightning rod conductors) shall not be employed as electrodes for protectors.

(C) Electrode Connection Connections to grounding electrodes shall comply with 250.70.

(D) Bonding of Electrodes A bonding jumper, not smaller than 6 AWG copper or equivalent shall be connected between the communications grounding electrode and power grounding electrode system at the building or structure served where separate electrodes are used.

Exception: At mobile homes as covered in 800.106.

FPN No. 1: See 250.60 for use of air terminals (lightning rods).

FPN No. 2: Bonding together of all separate electrodes limits potential differences between them and between their associated wiring systems.

800.106 Primary Protector Grounding and Bonding at Mobile Homes

(A) Grounding Where there is no mobile home service equipment located in sight from, and not more than 9.0 m (30 ft) from, the exterior wall of the mobile home it serves or there is no mobile home disconnecting means grounded in accordance with 250.32 and located within sight from and not more than 9.0 m (30 ft) from, the exterior wall of the mobile home it serves, the primary protector grounding shall be in accordance with 800.100(B)(2).

(B) Bonding The primary protector grounding terminal or grounding electrode shall be bonded to the metal frame or available grounding terminal of the mobile home with a copper grounding conductor not smaller than 12 AWG by either of the following conditions:

(1) Where there is no mobile home service equipment or disconnecting means as in 800.106(A)
(2) Where the mobile home is supplied by cord and plug

V. Communications Wires and Cables Within Buildings

Data circuits between computers are classified as C circuits. In a typical office environment consisting of a of computers connected to a local area network, data w

as prevalent as telephone wiring. One common way to minimize the amount of cabling is to run the telephone and data circuits in the same cable, as illustrated in Exhibit 800.6. Section 725.56(D) requires that either a communications cable or a multipurpose cable be used for this purpose.

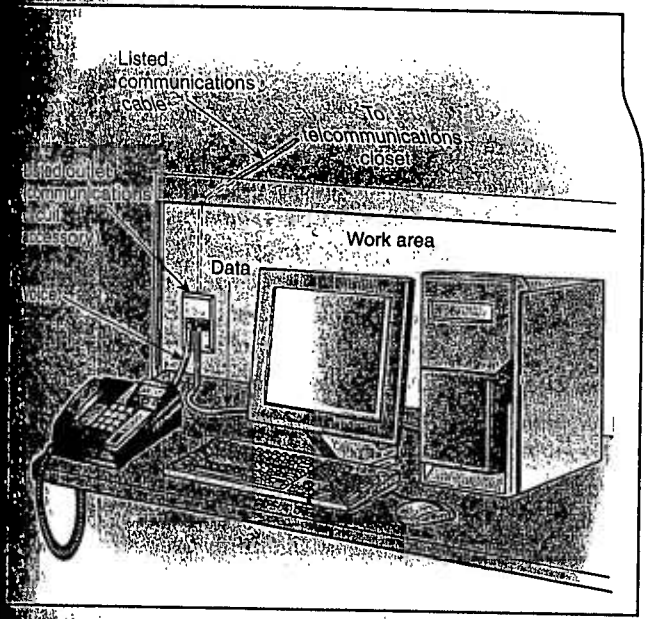


Exhibit 800.6 An example of telephone and data circuits in the same cable.

800.110 Raceways for Communications Wires and Cables

Where communications wires and cables are installed in a raceway, the raceway shall be either of a type permitted in Chapter 3 and installed in accordance with Chapter 3 or a listed nonmetallic raceway complying with 800.182, and installed in accordance with 362.24 through 362.56, where the requirements applicable to electrical nonmetallic tubing apply.

Exception: Conduit fill restrictions shall not apply.

800.113 Installation and Marking of Communications Wires and Cables

Listed communications wires and cables and listed multipurpose cables shall be installed as wiring within buildings. Communications cables and undercarpet communications wires shall be marked in accordance with Table 800.113. The cable voltage rating shall not be marked on the cable or on the undercarpet communications wire.

FPN: Voltage markings on cables may be misinterpreted to suggest that the cables may be suitable for Class 1, electric light, and power applications.

Table 800.113 Cable Markings

Cable Marking	Type	Reference
CMP	Communications plenum cable	800.179(A) and 800.154(A)
CMR	Communications riser cable	800.179(B) and 800.154(B)
CMG	Communications general-purpose cable	800.179(C) and 800.154(D) and (E)(1)
CM	Communications general-purpose cable	800.179(D) and 800.154(D) and (E)(1)
CMX	Communications cable, limited use	800.179(E) and 800.154(E)(2), (3), (4), and (5)
CMUC	Undercarpet communications wire and cable	800.179(F) and 800.154(E)(6)

FPN No. 1: Cable types are listed in descending order of fire resistance rating.

FPN No. 2: See the referenced sections for permitted uses.

Exception No. 1: Voltage markings shall be permitted where the cable has multiple listings and voltage marking is required for one or more of the listings.

Exception No. 2: Listing and marking shall not be required where the length of the cable within the building, measured from its point of entrance, does not exceed 15 m (50 ft) and the cable enters the building from the outside and is terminated in an enclosure or on a listed primary protector.

FPN No. 1 to Exception No. 2: Splice cases or terminal boxes, both metallic and plastic types, are typically used as enclosures for splicing or terminating telephone cables.

FPN No. 2 to Exception No. 2: This exception limits the length of unlisted outside plant cable to 15 m (50 ft), while 800.90(B) requires that the primary protector be located as close as practicable to the point at which the cable enters the building. Therefore, in installations requiring a primary protector, the outside plant cable may not be permitted to extend 15 m (50 ft) into the building if it is practicable to place the primary protector closer than 15 m (50 ft) to the entrance point.

800.133 Installation of Communications Wires, Cables, and Equipment

Communications wires and cables from the protector to the equipment or, where no protector is required, communications wires and cables attached to the outside or inside of the building shall comply with 800.133(A) through 800.133(D).

Section 800.133 includes non–power-limited fire alarm circuits covered by Article 760 and network-powered broadband communications circuits covered by Article 830.

(A) Separation from Other Conductors

(1) In Raceways, Boxes, and Cables

(a) Other Power-Limited Circuits. Communications cables shall be permitted in the same raceway or enclosure with cables of any of the following:

(1) Class 2 and Class 3 remote-control, signaling, and power-limited circuits in compliance with Article 725
(2) Power-limited fire alarm systems in compliance with Article 760
(3) Nonconductive and conductive optical fiber cables in compliance with Article 770
(4) Community antenna television and radio distribution systems in compliance with Article 820
(5) Low-power network-powered broadband communications circuits in compliance with Article 830

(b) Class 2 and Class 3 Circuits. Class 1 circuits shall not be run in the same cable with communications circuits. Class 2 and Class 3 circuit conductors shall be permitted in the same cable with communications circuits, in which case the Class 2 and Class 3 circuits shall be classified as communications circuits and shall meet the requirements of this article. The cables shall be listed as communications cables or multipurpose cables.

Exception: Cables constructed of individually listed Class 2, Class 3, and communications cables under a common jacket shall not be required to be classified as communications cable. The fire-resistance rating of the composite cable shall be determined by the performance of the composite cable.

(c) Electric Light, Power, Class 1, Non–Power-Limited Fire Alarm, and Medium Power Network-Powered Broadband Communications Circuits in Raceways, Compartments, and Boxes. Communications conductors shall not be placed in any raceway, compartment, outlet box, junction box, or similar fitting with conductors of electric light, power, Class 1, non–power-limited fire alarm, or medium power network-powered broadband communications circuits.

Exception No. 1: Where all of the conductors of electric light, power, Class 1, non–power-limited fire alarm, and medium power network-powered broadband communications circuits are separated from all of the conductors of communications circuits by a permanent barrier or listed divider.

This exception recognizes the use of a listed field-installed divider to separate the communications circuits from the power circuits.

Exception No. 2: Power conductors in outlet boxes, junction boxes, or similar fittings or compartments where such conductors are introduced solely for power supply to communications equipment. The power circuit conductors shall be routed within the enclosure to maintain a minimum of 6 mm (0.25 in.) separation from the communications circuit conductors.

Exception No. 3: As permitted by 620.36.

(2) Other Applications Communications wires and cables shall be separated at least 50 mm (2 in.) from conductors of any electric light, power, Class 1, non–power-limited fire alarm, or medium power network-powered broadband communications circuits.

Exception No. 1: Where either (1) all of the conductors of the electric light, power, Class 1, non–power-limited fire alarm, and medium power network-powered broadband communications circuits are in a raceway or in metal-sheathed, metal-clad, nonmetallic-sheathed, Type AC, or Type UF cables, or (2) all of the conductors of communications circuits are encased in raceway.

Exception No. 2: Where the communications wires and cables are permanently separated from the conductors of electric light, power, Class 1, non–power-limited fire alarm, and medium power network-powered broadband communications circuits by a continuous and firmly fixed nonconductor such as porcelain tubes or flexible tubing, in addition to the insulation on the wire.

(B) Cable Trays Types CMP, CMR, CMG, and CM communications cables shall be permitted to be installed in cable trays. Communications raceways, as described in 800.170, shall be permitted to be installed in cable trays.

Exhibit 800.7 shows overhead ladder–type cable tray that contains communications cables.

(C) Support of Conductors Raceways shall be used for their intended purpose. Communications cables or wires shall not be strapped, taped, or attached by any means to the exterior of any conduit or raceway as a means of support.

See 800.21 and 800.24, which require that communications cable be supported by the building structure in such a manner that it will not be damaged by ordinary building use.

Exception: Overhead (aerial) spans of communications cables or wires shall be permitted to be attached to the exterior of a raceway-type mast intended for the attachment and support of such conductors.

In some instances, the only way to achieve the proper clearance above roadways, driveways, or structures is by use of a mast. The exception to 800.133(C) permits overhead spans

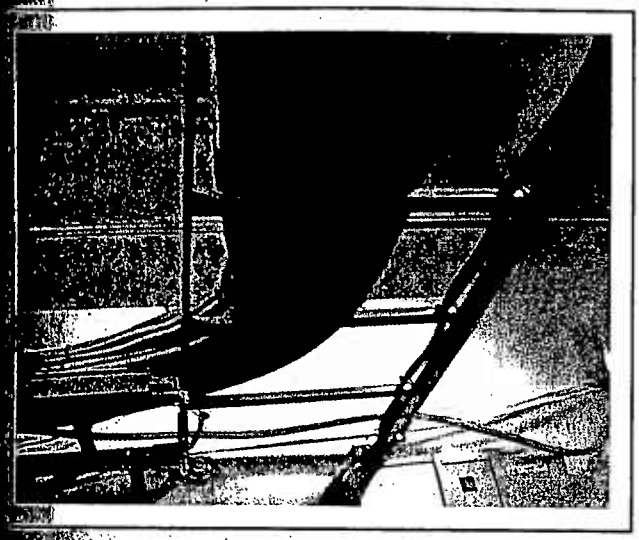


Exhibit 800.7 Overhead ladder–type cable tray containing communications cables.

...mmunications cable to be attached to the exterior of a ...eway-type mast only if the mast is installed to support ...mmunications cable. Section 230.28 prohibits the attachment of communications cable to a service mast.

(D) Wiring in Ducts for Dust, Loose Stock, or Vapor Removal Section 300.22(A) shall apply.

800.154 Applications of Listed Communications Wires and Cables and Communications Raceways

...mmunications wires and cables shall comply with the ...irements of 800.154(A) through 800.154(F) or where ...le substitutions are made in accordance with 800.154(G).

...t the length of unlisted outside-plant cable permitted ...building depends on the location of the primary protector in accordance with 800.90(B) and 800.113 Exception No. 2.

Section 800.154(A) covers listed plenum communications raceways. These raceways provide limited mechanical protection and ease of installation, but they are limited to Type CMP plenum-rated cable if installed in ducts and ple...

Section 800.154(B) covers riser raceways. Riser raceways provide limited mechanical protection and ease of installation, but they are limited to Type CMP plenum-rated ...r Type CMR riser-rated cable if installed in risers. ...e 800.154 lists the permitted uses of field applications ...various cable types.

(A) Plenum Cables installed in ducts, plenums, and other ...es used for environmental air shall be Type CMP. Abandoned cables shall not be permitted to remain. Types CMP, CMR, CMG, CM, and CMX and communications wire installed in compliance with 300.22 shall be permitted. Listed plenum communications raceways shall be permitted to be installed in ducts and plenums as described in 300.22(B) and in other spaces used for environmental air as described in 300.22(C). Only Type CMP cable shall be permitted to be installed in raceways.

FPN: See 8.14.1 of NFPA 13-2002, *Installation of Sprinkler Systems*, for requirements for sprinklers in concealed spaces containing exposed combustibles.

(B) Riser Cables installed in risers shall comply with 800.154(B)(1), (B)(2), or (B)(3).

(1) Cables in Vertical Runs Cables installed in vertical runs and penetrating more than one floor, or cables installed in vertical runs in a shaft, shall be Type CMR. Floor penetrations requiring Type CMR shall contain only cables suitable for riser or plenum use. Abandoned cables shall not be permitted to remain. Listed riser communications raceways shall be permitted to be installed in vertical riser runs in a shaft from floor to floor. Only Type CMR and CMP cables shall be permitted to be installed in these raceways.

(2) Metal Raceways or Fireproof Shafts Listed communications cables shall be encased in a metal raceway or located in a fireproof shaft having firestops at each floor.

(3) One- and Two-Family Dwellings Type CM and CMX cable shall be permitted in one- and two-family dwellings.

FPN: See 800.3(C) for firestop requirements for floor penetrations.

(C) Distributing Frames and Cross-Connect Arrays Listed communications wire and Types CMP, CMR, CMG, and CM communications cables shall be used in distributing frames and cross-connect arrays.

(D) Cable Trays Types CMP, CMR, CMG, and CM communications cables shall be permitted to be installed in cable trays.

(E) Other Wiring Within Buildings Cables installed in building locations other than the locations covered in 800.154(A) through 800.154(D) shall be in accordance with 800.154(E)(1) through (E)(6).

(1) General Cables shall be Type CMG or Type CM. Listed communications general-purpose raceways shall be permitted. Only Types CMG, CM, CMR, or CMP cables shall be permitted to be installed in general-purpose communications raceways.

(2) In Raceways Listed communications wires that are enclosed in a raceway of a type included in Chapter 3 shall be permitted.

(3) Nonconcealed Spaces Type CMX communications cable shall be permitted to be installed in nonconcealed spaces where the exposed length of cable does not exceed 3 m (10 ft).

(4) One- and Two-Family Dwellings Type CMX communications cable less than 6 mm (0.25 in.) in diameter shall be permitted to be installed in one- and two-family dwellings.

(5) Multi-Family Dwellings Type CMX communications cable less than 6 mm (0.25 in.) in diameter shall be permitted to be installed in nonconcealed spaces in multi-family dwellings.

(6) Under Carpets Type CMUC undercarpet communications wires and cables shall be permitted to be installed under carpet.

(F) Hybrid Power and Communications Cable Hybrid power and communications cable listed in accordance with 800.179(I) shall be permitted to be installed in one- and two-family dwellings.

(G) Cable Substitutions The uses and permitted substitutions for communications cables listed in Table 800.154 shall be considered suitable for the purpose and shall be permitted.

Table 800.154 Cable Substitutions

Cable Type	Use	References	Permitted Substitutions
CMR	Communications riser cable	800.154(B)	CMP
CMG, CM	Communications general-purpose cable	800.154(E)(1)	CMP, CMR
CMX	Communications cable, limited use	800.154(E)	CMP, CMR, CMG, CM

FPN: See Figure 800.154, Cable Substitution Hierarchy.

FPN: For information on Types CMP, CMR, CMG, CM, and CMX cables, see 800.179.

VI. Listing Requirements

800.170 Equipment

Communications equipment shall be listed as being suitable for electrical connection to a telecommunications network.

FPN: One way to determine applicable requirements is to refer to UL 1950-1993, *Standard for Safety of Information Technology Equipment, Including Electrical Business Equipment*, third edition; UL 1459-1995, *Standard for Safety, Telephone Equipment*, third edition; or UL 1863-1995, *Standard for Safety, Communications Circuit Accessories*, second edition. For information on listing requirements for communications raceways, see UL 2024-1995, *Standard for Optical Fiber Raceways*.

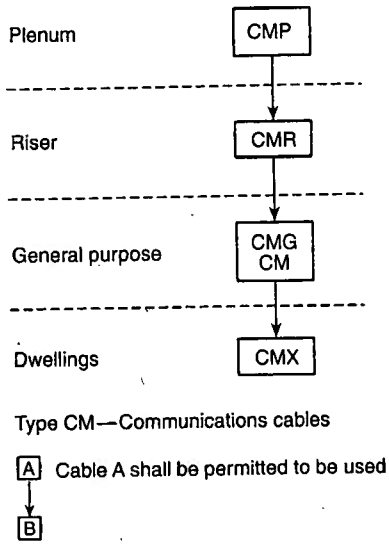


Figure 800.154 Cable Substitution Hierarchy.

(A) Primary Protectors The primary protector shall consist of an arrester connected between each line conductor and ground in an appropriate mounting. Primary protector terminals shall be marked to indicate line and ground, as applicable.

FPN: One way to determine applicable requirements for a listed primary protector is to refer to ANSI/UL 497-1995, *Standard for Protectors for Paired Conductor Communications Circuits*.

(B) Secondary Protectors The secondary protector shall be listed as suitable to provide means to safely limit current to less than the current-carrying capacity of listed indoor communications wire and cable, listed telephone set line cords, and listed communications terminal equipment having ports for external wire line communications circuits. Any overvoltage protection, arresters, or grounding connection shall be connected on the equipment terminals side of the secondary protector current-limiting means.

FPN: One way to determine applicable requirements for a listed secondary protector is to refer to UL 497A-1996, *Standard for Secondary Protectors for Communications Circuits*.

800.173 Drop Wire and Cable

Communications wires and cables without a metallic shield, running from the last outdoor support to the primary protector, shall be listed as being suitable for the purpose and shall have current-carrying capacity as specified in 800.90(A)(1)(b) or (A)(1)(c).

800.179 Communications Wires and Cables

Communications wires and cables shall have a voltage rating of not less than 300 volts and shall be listed in accordance

800.179(A) through 800.179(J). Conductors in communications cables, other than in a coaxial cable, shall be

tion 800.179 requires a rating of 300 volts for the follow-
ons:
o coordinate with protector installation requirements
e protectors are not required within a block unless
cable is exposed to over 300 volts)
o recognize the fact that primary protectors are de-
gned to allow voltages below 300 to pass
accommodate the voltages ordinarily found on a
phone line (48 volts dc plus ringing voltage up to
0 volts rms)
o permit communications cable to substitute for 300-
power-limited fire-protective signaling cable

N: See 800.170 for listing requirement for equipment.

Type CMP Type CMP communications plenum cable be listed as being suitable for use in ducts, plenums, other spaces used for environmental air and shall also ed as having adequate fire-resistant and low smoke-
cing characteristics.

he commentary following 725.82(A), FPN, for informa-
a test method for wires and cables to be installed
t raceways in plenums and other spaces used for
nmental air.

FPN: One method of defining a cable that is low smoke-producing cable and fire-resistant cable is that the cable exhibits a maximum peak optical density of 0.5 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.52 m (5 ft) or less when tested in accordance with NFPA 262-2002, *Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.*

Type CMR Type CMR communications riser cable be listed as being suitable for use in a vertical run in ft or from floor to floor and shall also be listed as g fire-resistant characteristics capable of preventing carrying of fire from floor to floor.

he commentary following 725.82(B), FPN, for informa-
a test for defining fire-resistant characteristics capa-
reventing fire spread from floor to floor.

FPN: One method of defining fire-resistant characteristics capable of preventing the carrying of fire from floor to floor is that the cables pass the requirements of ANSI/UL 1666-2002, *Standard Test for Flame Propagation Height of Electrical and Optical-Fiber Cable Installed Vertically in Shafts.*

(C) Type CMG Type CMG general-purpose communications cable shall be listed as being suitable for general-purpose communications use, with the exception of risers and plenums, and shall also be listed as being resistant to the spread of fire.

See the commentary following 725.82(C), FPN, for information on the UL vertical tray flame test.

FPN: One method of defining *resistant to the spread of fire* is for the damage (char length) not to exceed 1.5 m (4 ft 11 in.) when performing the vertical flame test for cables in cable trays, as described in CSA C22.2 No. 0.3-M-1985, *Test Methods for Electrical Wires and Cables.*

(D) Type CM Type CM communications cable shall be listed as being suitable for general-purpose communications use, with the exception of risers and plenums, and shall also be listed as being resistant to the spread of fire.

See the commentary following 725.82(D), FPN, for information on test methods for determining whether cable is resistant to the spread of fire.

FPN: One method of defining *resistant to the spread of fire* is that the cables do not spread fire to the top of the tray in the vertical-tray flame test in ANSI/UL 1581-1991, *Reference Standard for Electrical Wires, Cables and Flexible Cords.* Another method of defining *resistant to the spread of fire* is for the damage (char length) not to exceed 1.5 m (4 ft 11 in.) when performing the vertical flame test for cables in cable trays, as described in CSA C22.2 No. 0.3-M-1985, *Test Method for Electrical Wires and Cables.*

(E) Type CMX Type CMX limited-use communications cable shall be listed as being suitable for use in dwellings and for use in raceway and shall also be listed as being resistant to flame spread.

FPN: One method of determining that cable is resistant to flame spread is by testing the cable to the VW-1 (vertical-wire) flame test in ANSI/UL 1581-1991, *Reference Standard for Electrical Wires, Cables and Flexible Cords.*

(F) Type CMUC Undercarpet Wire and Cable Type CMUC undercarpet communications wire and cable shall be listed as being suitable for undercarpet use and shall also be listed as being resistant to flame spread.

FPN: One method of determining that cable is resistant to flame spread is by testing the cable to the VW-1 (vertical-wire) flame test in ANSI/UL 1581-1991, *Reference Standard for Electrical Wires, Cables and Flexible Cords.*

(G) Multipurpose (MP) Cables Until July 1, 2003, cables that meet the requirements for Types CMP, CMR, CMG,

and CM and also satisfy the requirements of 760.82(B) for multiconductor cables and 760.82(H) for coaxial cables shall be permitted to be listed and marked as multipurpose cable Types MPP, MPR, MPG, and MP, respectively.

The deletion of stranding requirements for fire alarm cable resulted in an increased number of copper communications cables, such as Types MPP, MPR, MPG, and MP, that qualify for listing as multipurpose cable.

(H) Communications Circuit Integrity (CI) Cable Cables suitable for use in communications systems to ensure survivability of critical circuits during a specified time under fire conditions shall be listed as circuit integrity (CI) cable. Cables identified in 800.179 (A), (B), (C), (D), and (E) that meet the requirements for circuit integrity shall have the additional classification using the suffix "CI."

FPN: One method of defining circuit integrity (CI) cable is by establishing a minimum 2-hour fire resistance rating for the cable when tested in accordance with UL 2196-1995, *Standard for Tests of Fire Resistive Cables.*

(I) Communications Wires Communications wires, such as distributing frame wire and jumper wire, shall be listed as being resistant to the spread of fire.

FPN: One method of defining *resistant to the spread of fire* is that the cables do not spread fire to the top of the tray in the vertical-tray flame test in ANSI/UL 1581-1991, *Reference Standard for Electrical Wires, Cables and Flexible Cords.* Another method of defining *resistant to the spread of fire* is for the damage (char length) not to exceed 1.5 m (4 ft 11 in.) when performing the vertical flame test for cables in cable trays, as described in CSA C22.2 No. 0.3-M-1985, *Test Methods for Electrical Wires and Cables.*

(J) Hybrid Power and Communications Cable Listed hybrid power and communications cable shall be permitted where the power cable is a listed Type NM or NM-B conforming to the provisions of Article 334, and the communications cable is a listed Type CM, the jackets on the listed NM or NM-B and listed CM cables are rated for 600 volts minimum, and the hybrid cable is listed as being resistant to the spread of fire.

FPN: One method of defining *resistant to the spread of fire* is that the cables do not spread fire to the top of the tray in the vertical-tray flame test in ANSI/UL 1581-1991, *Reference Standard for Electrical Wires, Cables and Flexible Cords.* Another method of defining *resistant to the spread of fire* is for the damage (char length) not to exceed 1.5 m (4 ft 11 in.) when performing the vertical flame test for cables in cable trays, as described in CSA C22.2 No. 0.3-M-1985, *Test Methods for Electrical Wires and Cables.*

800.182 Communications Raceways

Communications raceways shall be listed in accordance with 800.182(A) through 800.182(C).

(A) Plenum Communications Raceways Plenum communications raceways listed as plenum optical fiber raceways shall be permitted for use in ducts, plenums, and other spaces used for environmental air and shall also be listed as having adequate fire-resistant and low smoke-producing characteristics.

FPN: One method of defining that an optical fiber raceway is a low smoke producing raceway and a fire-resistant raceway is that the raceway exhibits a maximum peak optical density of 0.5 or less, an average optical density of 0.15 or less, and a maximum flame spread distance of 1.52 m (5 ft) or less when tested in accordance with the plenum test in UL 2024, *Standard for Optical Fiber Cable Raceway.*

(B) Riser Communications Raceways Riser communications raceways shall be listed as having adequate fire-resistant characteristics capable of preventing the carrying of fire from floor to floor.

FPN: One method of defining fire-resistant characteristics capable of preventing the carrying of fire from floor to floor is that the raceways pass the requirements of the test for Flame Propagation (riser) in UL 2024, *Standard for Optical Fiber Cable Raceway.*

(C) General-Purpose Communications Raceways General-purpose communications raceways shall be listed as being resistant to the spread of fire.

The communications raceways covered in 800.182(A) through (C) are listed raceways used in plenum, riser, and general-purpose applications. This listing includes raceways and fittings for the installation of communications cables in accordance with Article 800. These raceways are not suitable for installation of wires, cords, or cabling without communications members.

A raceway marked "plenum" is suitable for use in ducts, plenums, or other spaces used for environmental air in accordance with 800.154(A) when used to enclose communications cable marked CMP. This raceway exhibits a maximum peak optical density of 0.5, a maximum average optical density of 0.15, and a maximum flame spread distance of 5 ft when tested in accordance with UL 2024, *Standard for Optical-Fiber Cable Raceway.* This raceway is identified by a marking on its surface or on a marker tape indicating "plenum." A raceway marked "plenum" is also suitable for installation in risers when used to enclose communications cable marked CMP or CMR and for general-purpose use when used to enclose communications cable marked CMP, CMR, CMG, or CM; and for dwellings when used to enclose communications cable marked CMP, CMR, CMG, CM, or CMX.

A raceway marked "riser" is suitable for installation ... s in accordance with 800.154(B) when used to enclose ... munications cable marked CMP or CMR. This raceway ... re-resistant characteristics capable of preventing the ... of fire from floor to floor, and it meets the test ... ments of UL 2024, *Standard for Optical-Fiber Cable* ...). This raceway is identified by a marking on its ... or on a marker tape indicating "riser." A raceway ... ed "riser" is also suitable for general-purpose use when ... enclose communications cable marked CMP, CMR, ... or CM, and for dwellings when used to enclose com- ... nications cable marked CMP, CMR, CMG, CM, or CMX. ... raceway marked "general purpose" is suitable for ... lation in general-purpose areas in accordance with ... 154(D) when used to enclose communications cable ... CMP, CMR, CMG, or CM, and for dwellings when ... to enclose communications cable marked CMP, CMR, ... CM, or CMX.

... liable raceway is raceway that can be bent by hand ... the use of tools. The smallest radius of the curve ... inner edge of any bend to which the raceway can be ... without cracking either on the outer surface or internally ... less than 2½ times the outside diameter of the raceway.

FPN: One method of defining *resistance to the spread of fire* is that the raceways pass the requirements of the Vertical-Tray Flame Test (General Use) in UL 2024, *Standard for Optical Fiber Cable Raceway.*

ARTICLE 810
Radio and Television Equipment

Contents

I. General

810.1 Scope

This article covers antenna systems for radio and television receiving equipment, amateur radio transmitting and receiving equipment, and certain features of transmitter safety. This article covers antennas such as multi-element, vertical rod, and dish, and also covers the wiring and cabling that