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WORKING DRAFT OF NEC CODE-MAKING PANEL 5 MEETING OUTPUT

CONTENT NOT FINAL – SUBJECT TO REVISION PRIOR TO LETTER BALLOT AND PUBLICATION OF SECOND DRAFT REPORT

Document: National Electrical Code®

Revision Cycle: A2025

Meeting Date: October 2024

Panel Activity: Comment Stage

This is a working draft, prepared by NFPA staff, to record the output generated at the Code-Making Panel 5 Second Draft Meeting. It includes draft copies of the Second Revisions and any Global Revisions.

It is being made available to Panel members for the purpose of facilitating early review, particularly for those Panel members who may be seeking input from their respective organizations in preparation for the Second Draft Ballot.

Second Revision No. 8353-NFPA 70-2024 [Global Comment]

Change all instances of "overcurrent device" to use the defined term "overcurrent protective device" or the acronym "OCPD" in the following sections of Articles 100, 200, 250, and 270, as shown:

ARTICLE 100

Ground-Fault Current Path, Effective. (Effective Ground-Fault Current Path):

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

Ground-Fault Protection of Equipment (GFPE):

A system intended to provide protection of equipment from damaging line-to-ground fault currents by operating to cause a disconnecting means to open all ungrounded conductors of the faulted circuit. This protection is provided at current levels less than those required to protect conductors from damage through the operation of a supply circuit overcurrent protective device(OCPD) . (CMP-5)

ARTICLE 200

200.10(E):

Appliances that have a single-pole switch or a single-pole ~~overcurrent device~~ OCPD in the line or any line-connected screw shell lampholders, and that are to be connected by (1) a permanent wiring method or (2) field-installed attachment plugs and cords with three or more wires (including the equipment grounding conductor), shall have means to identify the terminal for the grounded circuit conductor (if any).

ARTICLE 250

250.4(A)(5)(a):

(a) *Opening ~~Overcurrent Protective Device OCPD~~ . Electrical equipment and wiring and other electrically conductive material likely to become energized shall be installed such that a low-impedance circuit is created facilitating the operation of the ~~overcurrent device~~ OCPD or ground detector for impedance grounded systems.*

250.4(B)(4):

Electrical equipment, wiring, and other electrically conductive material likely to become energized shall be installed in a manner that creates a low-impedance circuit from any point on the wiring system to the electrical supply source to facilitate the operation of ~~overcurrent devices~~ OCPDs should a second ground fault from a different phase occur on the wiring system. The earth shall not be considered as an effective fault-current path.

250.30(A)(1):

An unspliced system bonding jumper shall comply with 250.28(A) through 250.28(D). This connection shall be made at any single point on the separately derived system from the source to the first system disconnecting means or ~~overcurrent device~~ OCPD , or it shall be made at the

source of a separately derived system that has no disconnecting means or ~~overcurrent devices~~ OCPDs , in accordance with 250.30(A)(1)(a) or 250.30(A)(1)(b). The system bonding jumper shall remain within the enclosure where it originates. If the source is located outside the building or structure supplied, a system bonding jumper shall be installed at the grounding electrode connection in compliance with 250.30(C).

250.36(D):

The impedance grounding conductor shall be permitted to be installed in a separate raceway from the ungrounded conductors. It shall not be required to run this conductor with the phase conductors to the first system disconnecting means or ~~overcurrent device~~ OCPD .

250.36(E)(1):

Impedance bonding jumpers shall be unspliced conductors run from the first system disconnecting means or ~~overcurrent device~~ OCPD to the grounding electrode side of the impedance grounding device.

250.102(D):

(D) Size — Equipment Bonding Jumper on Load Side of an ~~Overcurrent Device~~ ~~OCPD~~ .

The equipment bonding jumper on the load side of an ~~overcurrent device(s)~~ OCPD shall be sized in accordance with 250.122.

A single common continuous equipment bonding jumper shall be permitted to connect two or more raceways or cables if the bonding jumper is sized in accordance with 250.122 for the largest ~~overcurrent device~~ OCPD supplying circuits therein.

250.118(A)(5), (6) & (7):

(5) Listed flexible metal conduit meeting all the following conditions:

(1) The conduit is terminated in listed fittings.

(2) The circuit conductors contained in the conduit are protected by ~~overcurrent devices~~ OCPDs rated at 20 amperes or less.

(3) The size of the conduit does not exceed metric designator 35 (trade size 1¼).

(4) The combined length of flexible metal conduit, flexible metallic tubing, and liquidtight flexible metal conduit in the same effective ground-fault current path does not exceed 1.8 m (6 ft).

(5) If flexibility is necessary to minimize the transmission of vibration from equipment or to provide flexibility for equipment that requires movement after installation, a wire-type equipment grounding conductor or a bonding jumper in accordance with 250.102(E)(2) is installed.

(6) If flexible metal conduit is constructed of stainless steel, a wire-type equipment grounding conductor or bonding jumper in accordance with 250.102(E)(2) is installed.

(6) Listed liquidtight flexible metal conduit meeting all the following conditions:

(1) The conduit is terminated in listed fittings.

(2) For metric designators 12 through 16 (trade sizes ⅜ through ½), the circuit conductors contained in the conduit are protected by ~~overcurrent devices~~ OCPDs rated at 20 amperes or less.

(3) For metric designators 21 through 35 (trade sizes ¾ through 1¼), the circuit conductors contained in the conduit are protected by overcurrent devices rated not more than 60 amperes and there is no flexible metal conduit, flexible metallic tubing, or liquidtight flexible

metal conduit in metric designators 12 through 16 (trade sizes ⅜ through ½) in the effective ground-fault current path.

(4) The combined length of flexible metal conduit, flexible metallic tubing, and liquidtight flexible metal conduit in the same effective ground-fault current path does not exceed 1.8 m (6 ft).

(5) If flexibility is necessary to minimize the transmission of vibration from equipment or to provide flexibility for equipment that requires movement after installation, a wire-type equipment grounding conductor or a bonding jumper in accordance with 250.102(E)(2)is installed.

(6) If liquidtight flexible metal conduit contains a stainless steel core, a wire-type equipment grounding conductor or a bonding jumper in accordance with 250.102(E)(2)is installed.

(7) Flexible metallic tubing, if the tubing is terminated in listed fittings and meets the following conditions:

(1) The circuit conductors contained in the tubing are protected by ~~overcurrent devices~~ OCPDs rated at 20 amperes or less.

(2) The combined length of flexible metal conduit, flexible metallic tubing, and liquidtight flexible metal conduit in the same effective ground-fault current path does not exceed 1.8 m (6 ft).

250.122(C):

A single equipment grounding conductor shall be permitted to be installed for multiple circuits that are installed in the same raceway, cable, trench, or cable tray. It shall be sized from Table 250.122(A) for the largest ~~overcurrent device~~ OCPD protecting circuit conductors in the raceway, cable, trench, or cable tray. Equipment grounding conductors installed in cable trays shall meet the minimum requirements of 392.10(B)(1)(c).

250.122(F)(1)(a):

If circuit conductors are connected in parallel in the same raceway, auxiliary gutter, or cable tray, a single wire-type conductor sized in accordance with 250.122 based on the ~~overcurrent protective device~~ OCPD for the feeder or branch circuit shall be permitted as the equipment grounding conductor.

250.122(F)(1)(b):

If conductors are installed in multiple raceways and are connected in parallel, a wire-type equipment grounding conductor, if used, shall be installed in each raceway, be connected in parallel, and comply with the following:

(1)

(a) The equipment grounding conductor installed in each raceway shall be sized in accordance with 250.122 based on the rating of the ~~overcurrent protective device~~ OCPD for the feeder or branch circuit.

(b) The equipment grounding conductor in each raceway shall not be required to be larger than the largest ungrounded conductor in the raceway.

250.122(F)(2)(a):

Except as provided in 250.122(F)(2)(c) for raceway, trench, or cable tray installations, the equipment grounding conductor in each multiconductor cable shall be sized in accordance with 250.122 based on the ~~overcurrent protective device~~ OCPD for the feeder or branch circuit.

250.122(G):

Equipment grounding conductors installed with feeder taps shall not be smaller than shown in Table 250.122(A) based on the rating of the ~~overcurrent device~~ OCPD ahead of the feeder on the supply side ahead of the tap but shall not be required to be larger than the tap conductors.

250.142(A):

A grounded circuit conductor shall be permitted to be connected to non-current-carrying metal parts of equipment, raceways, and other enclosures at any of the following locations:

(1) On the supply side or within the enclosure of the ac service disconnecting means

(2) On the supply side or within the enclosure of the main disconnecting means for separate buildings as provided in 250.32(B)(1) Exception No. 1

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

250.142(B):

Except as permitted in 250.30(A)(1) and 250.32(B)(1) Exception No. 1, grounded circuit conductors shall not be connected to non-current-carrying metal parts of equipment on the load side of the service disconnecting means or on the load side of separately derived systems disconnecting means or the ~~overcurrent devices~~ OCPDs for separately derived systems not having a main disconnecting means.

250.148(C):

A connection used for no other purpose shall be made between the metal box and the equipment grounding conductor(s). The equipment bonding jumper or equipment grounding conductor shall be sized from Table 250.122(A) based on the largest ~~overcurrent device~~ OCPD protecting circuit conductors in the box.

250.164(B):

If the dc system source is located on the premises, a grounding connection shall be made at one of the following:

(1) The source

(2) The first system disconnection means or ~~overcurrent device~~ OCPD

(3) By other means that accomplish system protection and that use equipment listed and identified for the use

250.169:

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 Article 250, 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~~ OCPD , or it shall be made at the source of a separately derived system that has no disconnecting means or ~~overcurrent devices~~ OCPDs .

ARTICLE 270

270.4(A)(5):

Electrical equipment and wiring and other electrically conductive material likely to become energized shall be installed in a manner that creates a low-impedance circuit facilitating the operation of the ~~overcurrent device~~ OCPD or ground detector for impedance grounded

systems. It shall be capable of safely carrying the maximum ground-fault current likely to be imposed on it from any point on the wiring system where a ground fault occurs to the electrical supply source. The earth shall not be considered as an effective ground-fault current path.

270.4(B)(4):

Electrical equipment, wiring, and other electrically conductive material likely to become energized shall be installed in a manner that creates a low-impedance circuit from any point on the wiring system to the electrical supply source to facilitate the operation of ~~overcurrent devices~~ OCPDs should a second ground fault from a different phase occur on the wiring system. The earth shall not be considered as an effective fault-current path.

270.30(A)(1):

An unspliced system bonding jumper shall comply with 270.28(A) through 270.28(D). This connection shall be made at any single point on the separately derived system from the source to the first system disconnecting means or ~~overcurrent device~~ OCPD , or it shall be made at the source of a separately derived system that has no disconnecting means or ~~overcurrent devices~~ OCPDs , in accordance with 270.30(A)(1)(a) or 270.30(A)(1)(b). The system bonding jumper shall remain within the enclosure where it originates. If the source is located outside the building or structure supplied, a system bonding jumper shall be installed at the grounding electrode connection in compliance with 270.30(C).

270.35(B):

If the generator is installed as a nonseparately derived system, and overcurrent protection is not integral with the generator assembly, a supply-side bonding jumper shall be installed between the generator equipment grounding terminal and the equipment grounding terminal, bar, or bus of the disconnecting mean(s) where the ~~overcurrent protective device~~ OCPD is located. It shall be sized in accordance with 270.102(C) based on the size of the conductors supplied by the generator.

270.36(D):

Impedance grounding conductors shall be permitted to be installed in separate raceways from ungrounded conductors. Running impedance grounding conductors with phase conductors to the first system disconnecting means or ~~overcurrent device~~ OCPD shall not be required.

270.36(E)(1):

Impedance bonding jumpers shall be unspliced conductors run from the first system disconnecting means or ~~overcurrent devices~~ OCPDs to the grounding electrode side of grounding impedance devices.

270.36(E)(2)(b):

(b) *Connected at First System Disconnection Means*. If the grounding electrode conductor is connected at the first system disconnecting means or ~~overcurrent device~~ OCPD , the impedance bonding jumper shall be sized the same as the impedance grounding conductor.

270.102(D):

The equipment bonding jumper on the load side of an ~~overcurrent device(s)~~ OCPD shall be sized in accordance with 270.122.

A single common continuous equipment bonding jumper shall be permitted to connect two or more raceways or cables if the bonding jumper is sized in accordance with 270.122 for the largest ~~overcurrent device~~ OCPD supplying circuits therein.

270.142(A):

A grounded circuit conductor shall be permitted to be connected to non-current-carrying metal parts of equipment, raceways, and other enclosures at any of the following locations:

(1) On the supply side or within the enclosure of the ac service disconnecting means

(2) On the supply side or within the enclosure of the main disconnecting means for separate buildings as provided in 270.32(B)(1) Exception No. 1

(3) On the supply side or within the enclosure of the main disconnecting means or ~~overcurrent devices~~ OCPDs of a separately derived system where permitted by 270.30(A)(1)

270.142(B):

Except as permitted in 270.30(A)(1), 270.32(B)(1) Exception No. 1, a grounded circuit conductor shall not be connected to non-current-carrying metal parts of equipment on the load side of the service disconnecting means or on the load side of a separately derived system disconnecting means or the ~~overcurrent devices~~ OCPDs for a separately derived system not having a main disconnecting means.

270.164(B):

If the dc system source is located on the premises, a grounding connection shall be made at one of the following:

(1) The source

(2) The first system disconnection means or ~~overcurrent device~~ OCPD

(3) By other means that accomplish system protection and that use equipment listed and identified for the use

270.169:

Except as otherwise permitted in 270.34 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 Article 270, 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~~ OCPD , or it shall be made at the source of a separately derived system that has no disconnecting means or ~~overcurrent devices~~ OCPDs .

Supplemental Information

File Name	Description	Approved
SR-8353_Global_OCPD.docx	staff use	

Submitter Information Verification

Committee: NEC-P05

Submittal Date: Wed Oct 23 20:21:16 EDT 2024

Committee Statement

Committee Statement: The terms for overcurrent protective devices were revised to comply with the updated definitions and usage.

Response Message: SR-8353-NFPA 70-2024

Public Comment No. 1645-NFPA 70-2024 [Global Input]

Second Revision No. 8196-NFPA 70-2024 [Detail]

Revise the title and scope of Article 750 as follows:

Article 750 Grounding~~,~~ and Bonding~~, and Overvoltage Protection~~ of Limited Energy Systems

750.1 Scope.

This article covers the grounding~~,~~ and bonding~~, and overvoltage protection~~ requirements for ~~Class 1 power-limited circuits, Class 2 circuits, Class 3 circuits, Class 4 circuits, optical fiber systems, communications systems, antenna systems, community antenna systems, network-powered broadband communications systems, premises-powered broadband communications systems, and power-limited fire alarm~~ limited-energy systems.

Submitter Information Verification

Committee: NEC-P05

Submittal Date: Mon Oct 21 17:37:49 EDT 2024

Committee Statement

Committee Statement: The words “Overvoltage Protection” are removed from the title of Article 750 to clarify that this article is only for grounding and bonding, not overvoltage protection. New Article 742 covers overvoltage protection of limited-energy systems. The list of system types in the article scope is replaced with the newly defined term “limited-energy systems.”

Response Message: SR-8196-NFPA 70-2024

Public Comment No. 1063-NFPA 70-2024 [Article 750]

Public Comment No. 945-NFPA 70-2024 [Section No. 750.1]

Second Revision No. 8349-NFPA 70-2024 [Detail]

[Article 100 - New Defintions]

Line-To-Ground.
An electrical reference between a current-carrying conductor other than a neutral and an equipment grounding conductor, grounded equipment, or ground. (CMP-5)

Line-to-Line.
An electrical reference between two current-carrying conductors in a circuit other than the neutral conductor. (CMP-5)

Line-to-Neutral.
An electrical reference between a current-carrying conductor other than a neutral and a neutral conductor or neutral point in a circuit . (CMP-5)

Submitter Information Verification

Committee: NEC-P05

Submittal Date: Wed Oct 23 19:04:32 EDT 2024

Committee Statement

Committee Statement: The new terms are needed to ensure that general requirements that exist across the code will be applied to all power systems, regardless of if the system is ac or dc for existing and future systems.

Response Message: SR-8349-NFPA 70-2024

Public Comment No. 1896-NFPA 70-2024 [New Definition after Definition: Line Isolation Monitor.]

Second Revision No. 8351-NFPA 70-2024 [Detail]

Revise 270.122(C) as follows:

(C) Metallic Insulation Shield or Armor of the Cables.

The metallic insulation shield, metallic armor, or a combination of both encircling the current-carrying conductors shall be permitted to be used as ~~an equipment grounding conductor~~ a ground-fault current path if it is rated for clearing time of ground-fault current protective device operation without damaging the metallic shield. The tape metallic insulation shield and drain wire insulation shield shall not be used as an equipment grounding conductor for solidly grounded systems.

Submitter Information Verification

Committee: NEC-P05

Submittal Date: Wed Oct 23 19:57:28 EDT 2024

Committee Statement

Committee Statement: The primary purpose of shielding is to confine the voltage stresses to the insulation, dissipate insulation leakage current, and drain off the capacitive charging current. The metallic insulation shields and armor are permitted as a ground fault current path. The revised text clarifies that these are not permitted to be used as an Equipment Grounding Conductor.

Deleting the last sentence, as proposed by PC-1542, would seem to permit the use of tape metallic insulation shields or drain wire insulation shields as equipment grounding conductors for solidly grounded systems. These are not suitable for this use.

Response Message: SR-8351-NFPA 70-2024

Public Comment No. 1542-NFPA 70-2024 [Section No. 270.122(C)]

Second Revision No. 8320-NFPA 70-2024 [Definition: Bonding Jumper, Impedance. (Impedance Bonding J...]

Bonding Jumper, Impedance (Impedance Bonding Conductor) . (Impedance Bonding Jumper)~~:~~

The connection in an impedance grounded system between the equipment grounding conductor(s) and the grounding electrode side of the impedance grounding device. (CMP-5)

Supplemental Information

File Name	Description	Approved
SR-8320_100_Impedance_Bonding_Jumper.docx	staff use	

Submitter Information Verification

Committee: NEC-P05

Submittal Date: Wed Oct 23 13:25:33 EDT 2024

Committee Statement

Committee Statement: The word "jumper" was maintained as users are more familiar with the term, and it gives the manufacturers time to change literature and instructions. The synonym “impedance bonding conductor” was added to assist with electronic searches.

Response Message: SR-8320-NFPA 70-2024

Public Comment No. 713-NFPA 70-2024 [Definition: Bonding Jumper, Impedance. (Impedance Bonding J...]

Second Revision No. 8316-NFPA 70-2024 [Definition: Bonding JumperConductor, Equipment. (Equipment ...]

Bonding ~~Conductor~~ Jumper , Equipment ~~.~~ (Equipment Bonding Conductor)

~~The~~

. (Equipment Bonding Jumper)

A component of the effective ground-fault current path that is the connection between two or more portions of the equipment grounding conductor. (CMP-5)

Supplemental Information

File Name	Description	Approved
SR-8316_100_Equipment_Bonding_Jumper.docx	staff use	

Submitter Information Verification

Committee: NEC-P05

Submittal Date: Wed Oct 23 13:12:17 EDT 2024

Committee Statement

Committee Statement: Currently, the definitions for EGC, MBJ, SBJ, SSBJ, and EBJ stand alone. By adding "a component of an Effective Ground-Fault Current Path" to these definitions, they are all brought together into a cohesive function.

The word “jumper” was restored as the primary term and “conductor” was changed to the synonym, as users are more familiar with the term “jumper” than “conductors” for this definition. This will give manufacturers and standards organizations time to change their standards, literature, and instructions.

Response Message: SR-8316-NFPA 70-2024

Public Comment No. 1030-NFPA 70-2024 [Definition: Bonding Conductor, Equipment. (Equipment Bondin...]

Second Revision No. 8317-NFPA 70-2024 [Definition: Bonding JumperConductor, Main. (Main Bonding Ju...]

Bonding ~~Conductor~~ Jumper , Main (Main Bonding ~~Jumper~~ Conductor). (Main Bonding ~~Conductor~~ Jumper)

~~The~~ A component of the effective ground-fault current path that is the connection between the grounded circuit conductor and the equipment grounding conductor, or the supply-side bonding conductor, or both, at the service equipment. (CMP-5)

Submitter Information Verification

Committee: NEC-P05

Submittal Date: Wed Oct 23 13:19:15 EDT 2024

Committee Statement

Committee Statement: Currently, the definitions for EGC, MBJ, SBJ, SSBJ, and EBJ stand alone. By adding "a component of an Effective Ground-Fault Current Path" to these definitions, they are all brought together into a cohesive function.

The word “jumper” was restored as the primary term and “conductor” was changed to the synonym, as users are more familiar with the term “jumper” than “conductors” for this definition. This will give manufacturers and standards organizations time to change their standards, literature, and instructions.

Response Message: SR-8317-NFPA 70-2024

Public Comment No. 1027-NFPA 70-2024 [Definition: Bonding Conductor, Main (Main Bonding Jumper). ...]

Second Revision No. 8318-NFPA 70-2024 [Definition: Bonding JumperConductor, Supply-Side. (Supply-S...]

Bonding ~~Conductor~~ Jumper , Supply-Side (Supply-Side Bonding ~~Jumper~~ Conductor). (Supply-Side Bonding ~~Conductor~~ Jumper)

A ~~conductor~~ component of the effective ground-fault current path that is installed on the supply side of a service or within a service equipment enclosure(s), or for a separately derived system, that ensures the required electrical conductivity between metal parts required to be electrically connected. (CMP-5)

Submitter Information Verification

Committee: NEC-P05

Submittal Date: Wed Oct 23 13:21:29 EDT 2024

Committee Statement

Committee Statement: Currently, the definitions for EGC, MBJ, SBJ, SSBJ, and EBJ stand alone. By adding "a component of an Effective Ground-Fault Current Path" to these definitions, they are all brought together into a cohesive function.

The word “jumper” was restored as the primary term and “conductor” was changed to the synonym, as users are more familiar with the term “jumper” than “conductors” for this definition. This will give manufacturers and standards organizations time to change their standards, literature, and instructions.

Response Message: SR-8318-NFPA 70-2024

Public Comment No. 1028-NFPA 70-2024 [Definition: Bonding Conductor, Supply-Side (Supply-Side Bon...]

Second Revision No. 8319-NFPA 70-2024 [Definition: Bonding JumperConductor, System. (System Bondin...]

Bonding ~~Conductor~~ Jumper , System (System Bonding ~~Jumper~~ Conductor). (System Bonding ~~Conductor~~ Jumper)

~~The~~ A component of the effective ground-fault current path that is the connection between the grounded circuit conductor and the supply-side bonding conductor, or the equipment grounding conductor, or both, at a separately derived system. (CMP-5)

Submitter Information Verification

Committee: NEC-P05

Submittal Date: Wed Oct 23 13:23:48 EDT 2024

Committee Statement

Committee Statement: Currently, the definitions for EGC, MBJ, SBJ, SSBJ, and EBJ stand alone. By adding "a component of an Effective Ground-Fault Current Path" to these definitions, they are all brought together into a cohesive function.

The word “jumper” was restored as the primary term and “conductor” was changed to the synonym, as users are more familiar with the term “jumper” than “conductors” for this definition. This will give manufacturers and standards organizations time to change their standards, literature, and instructions.

Response Message: SR-8319-NFPA 70-2024

Public Comment No. 1029-NFPA 70-2024 [Definition: Bonding Conductor, System (System Bonding Jumpe...]

Second Revision No. 8332-NFPA 70-2024 [Section No. 200.8(C)(1)]

(1) Cable Assemblies.

(a) Conductors that are part of cable assemblies that ~~has~~ have the insulation permanently reidentified to indicate ~~its~~ their use as ~~an ungrounded conductor~~ ungrounded conductors in accordance with 310.6(C) by marking tape, painting, or other effective means at ~~its~~ their termination and at each location where the ~~conductor is~~ conductors are visible and accessible shall be permitted if identification encircles the insulation and is a color other than white, gray, or green.

(b) If used for single-pole, 3-way or 4-way switch loops, the reidentified conductor shall be permitted to be used only for the supply to the switch, but not as a return conductor from the switch to the outlet.

Submitter Information Verification

Committee: NEC-P05

Submittal Date: Wed Oct 23 16:04:58 EDT 2024

Committee Statement

Committee Statement: The wording was revised to have consistent use of plural form and added a reference to 310.6(C) for the identification requirements.

Response Message: SR-8332-NFPA 70-2024

Public Comment No. 1233-NFPA 70-2024 [Section No. 200.8(C)(1)]

Public Comment No. 39-NFPA 70-2024 [Section No. 200.8(C)(1)]

Second Revision No. 8482-NFPA 70-2024 [Section No. 250.1]

250.1 Scope.

This article covers general requirements for grounding and bonding of electrical installations not over 1000 volts ac, 1500 volts dc, nominal, and the following specific requirements:

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

(2) Circuit conductor to be grounded on grounded systems

(3) Location of grounding connections

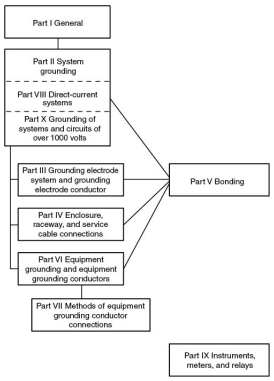
(4) Types and sizes of grounding and bonding conductors and electrodes

(5) Methods of grounding and bonding

(6) Conditions under which isolation, insulation, or guards are permitted to be substituted for grounding

Informational Note: See Figure Informational Note 250.1 for information on the organization of this article covering grounding and bonding requirements.

Figure Informational Note 250.1 Grounding and Bonding.



[REVISE THE FIGURE]

Supplemental Information

File Name	Description	Approved
Figure_250.1.jpg	staff use - draft revised figure for informational note. For editorial use only.	

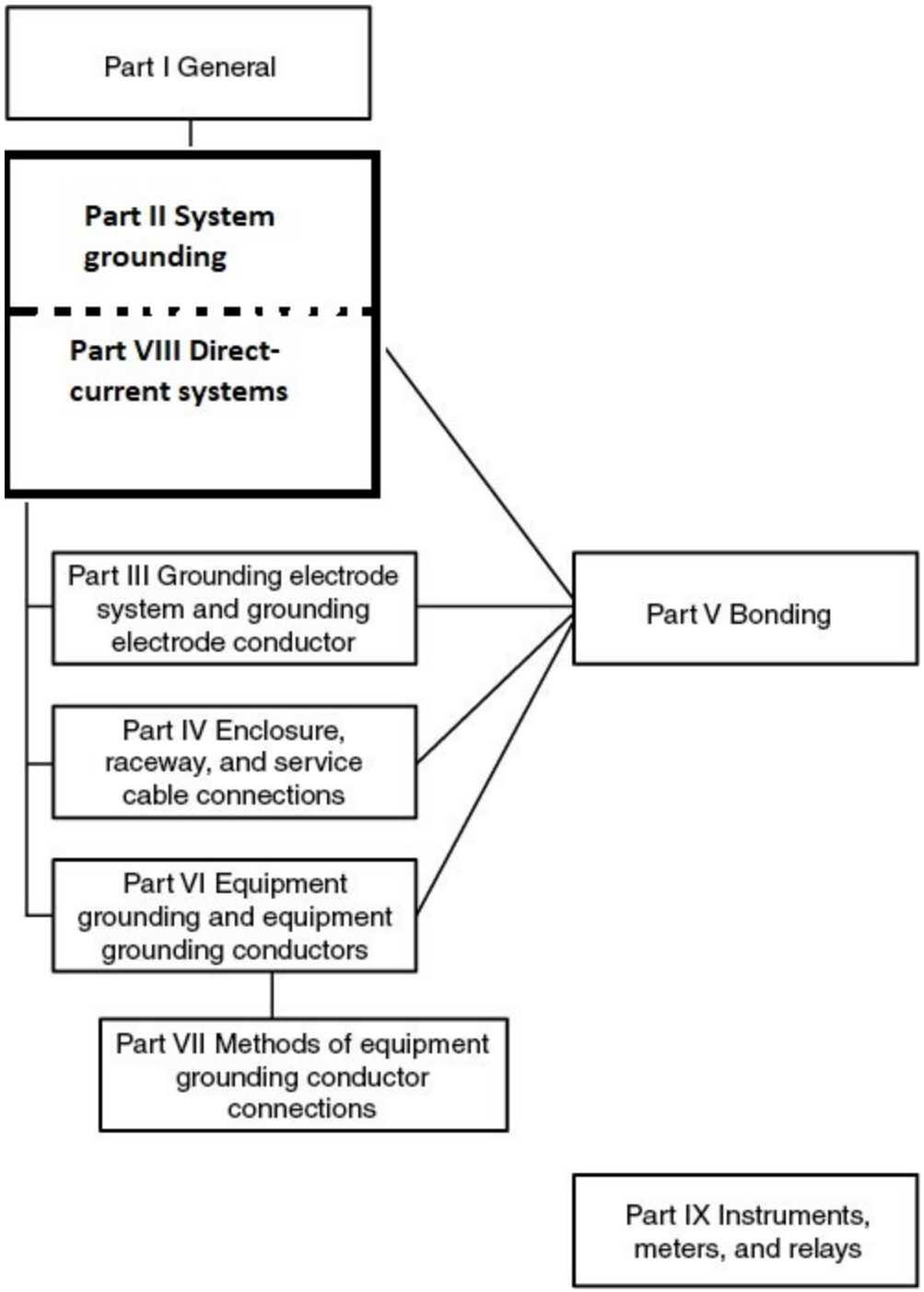
Submitter Information Verification

Committee: NEC-P05

Submittal Date: Fri Oct 25 01:38:30 EDT 2024

Committee Statement

Committee Statement:	This revision was developed by NFPA staff for editorial purposes, in accordance with 4.4.9.6.2 and 4.4.9.6.3 of the Regulations Governing the Development of NFPA Standards (nfpa.org/regs). The informational note figure was revised because Part X has been removed from Article 250 with the creation of Article 270.
Response Message:	SR-8482-NFPA 70-2024


Part I General
Part II System grounding
Part VIII Direct-current systems
Part III Grounding electrode system and grounding electrode conductor
Part IV Enclosure, raceway, and service cable connections
Part VI Equipment grounding and equipment grounding conductors
Part VII Methods of equipment grounding conductor connections
Part V Bonding
Part IX Instruments, meters, and relays

Second Revision No. 8333-NFPA 70-2024 [Section No. 250.4(A)(5)]

(5) Effective Ground-Fault Current Paths.

(a) *Opening Overcurrent Protective Device*. Electrical equipment and wiring and other electrically conductive material likely to become energized shall be installed such that a low-impedance circuit is created ~~facilitating~~ that will facilitate the operation of the overcurrent device or ground detector for impedance grounded systems.

(b) *Carrying Ground-Fault Current*. The effective ground-fault current path shall be capable of safely carrying the maximum ground-fault current likely to be imposed on it from any point on the wiring system where a ground fault occurs to the electrical supply source.

(c) ~~*Earth Not Suitable as Effective Ground-Fault Current Path*~~ *Use of the Earth* . The earth shall not be considered an effective ground-fault current path.

Submitter Information Verification

Committee: NEC-P05

Submittal Date: Wed Oct 23 16:16:35 EDT 2024

Committee Statement

Committee Statement: Section 250.4(A)(5)(a) was revised to better state the purpose of the OCPD.

The title of 250.4(A)(5)(c) was revised to remove the duplicate text that also appears in the requirement.

Response Message: SR-8333-NFPA 70-2024

Second Revision No. 8117-NFPA 70-2024 [Section No. 250.24(D)(2)]

(2) Conductors Connected in Parallel in Two or More Raceways or Cables.

If ungrounded service-entrance conductors are connected in parallel in two or more raceways or cables, the grounded conductors shall also be installed in each raceway or cable and be connected in parallel. The size of each grounded conductor in each raceway or cable shall be sized in accordance with ~~one of the following,~~ Table 250.102(C)(1) but not ~~be~~ smaller than 1/0 AWG. The minimum size shall be based on one of the following, as applicable :

(1) ~~Based on the~~ The largest ungrounded conductor in each raceway or cable

(2) ~~Based on the~~ The sum of the circular mil ~~areas~~ area of the largest set of ungrounded conductors ~~from each set~~ that are connected in parallel in each raceway or cable

Informational Note No. 1: See 310.10(G) for grounded conductors connected in parallel.

Informational Note No. 2: See Informative Annex D, Example D14 for information on sizing grounded conductors in parallel applications.

Submitter Information Verification

Committee: NEC-P05

Submittal Date: Mon Oct 21 11:42:53 EDT 2024

Committee Statement

Committee Statement: Reference to Table 250.102(C)(1) is added to clarify that grounded conductors are sized from that table, and additional editorial changes are made for clarity and usability.

PC-42 recommended to change "main bonding jumper" to "main bonding conductor" in the main paragraph (D). The use of the term “main bonding jumper” is acceptable. It is appropriate to refer to the grounded conductor in a parallel installation in plural format in accordance with Section 3.5.3 of the NEC Style Manual.

Response Message: SR-8117-NFPA 70-2024

Public Comment No. 42-NFPA 70-2024 [Section No. 250.24(D)]

Second Revision No. 8125-NFPA 70-2024 [Section No. 250.32(B)(1)]

(1) Supplied by Feeders or Branch Circuits.

Equipment grounding conductors, as described in 250.118(A), shall be run with supply conductors and be connected to the enclosure containing the building or structure disconnecting means and to the grounding electrode conductor. Equipment grounding conductors shall be used for grounding or bonding of equipment, structures, or frames required to be grounded or bonded. Equipment grounding conductors shall be sized in accordance with 250.122. Installed grounded conductors shall not be connected to the equipment grounding conductors or to the grounding electrodes.

Exception No. 1: For installations made in compliance with previous editions of this code that permitted such connection, grounded conductors run with the supply to the buildings or structures shall be permitted to serve as the ground-fault return paths if all of the following requirements continue to be met:

(1) Equipment grounding conductorsare not run with the supply to the buildings or structures.

(2) There are no continuous metallic paths bonded to the grounding systems in each building or structure involved.

(3) Ground-fault protection of equipment has not been installed on the supply side of the feeders.

If grounded conductorsare used for grounding in accordance with this exception, the size of the grounded conductors shall not be smaller than the larger of either of the following:

(1) The calculated neutral loads in accordance with 120.61

(2) The minimum equipment grounding conductors sized in accordance with 250.122

Exception No. 2: If system bonding jumpers are installed in accordance with 250.30(A)(1) Exception No. 2, the feeder grounded circuit conductors at the buildings or structures served shall be connected to the equipment grounding conductors, grounding electrode conductors, and the enclosures for the first disconnecting means.

Submitter Information Verification

Committee: NEC-P05

Submittal Date: Mon Oct 21 11:59:39 EDT 2024

Committee Statement

Committee Statement: The phrase “enclosure containing the” was added to clarify when equipment grounding conductors are connected at a building or structure that they are connected to the enclosure of the disconnecting means and not to the actual disconnecting means.

The use of the word “connected” was not deleted, as proposed in PC-1032, because it is consistent with usage elsewhere in Article 250.

Response Message: SR-8125-NFPA 70-2024

Public Comment No. 1032-NFPA 70-2024 [Section No. 250.32(B)(1)]

Second Revision No. 8334-NFPA 70-2024 [Section No. 250.35(B)]

(B) Nonseparately Derived Systems.

~~Where~~ If generators are installed as nonseparately derived systems, and overcurrent protection is not integral with the generator assembly, supply-side bonding jumpers shall be installed between the generator equipment grounding terminals and the equipment grounding terminal, bar, or bus of the disconnecting means. Supply-side bonding jumpers shall be one of the following:

(1) Nonflexible metal raceways

(2) Supply-side bonding jumpers of the wire type sized in accordance with 250.102(C)

(3) Supply-side bonding jumpers of the bus type with a cross-sectional area not smaller than supply-side bonding jumpers of the wire type as determined in 250.102(C)

Submitter Information Verification

Committee: NEC-P05

Submittal Date: Wed Oct 23 16:21:20 EDT 2024

Committee Statement

Committee Statement: The text is changed from “where” to “if” to indicate that the text describes a condition, not a location.

Response Message: SR-8334-NFPA 70-2024

Second Revision No. 8240-NFPA 70-2024 [Section No. 250.36(E)]

(E) Impedance Bonding Jumpers.

Impedance bonding jumpers shall meet the requirements of both 250.36 (E)(1) and 250.36(E) (2).

(1) Connection.

Impedance bonding jumpersshall be unspliced conductors run from the first system disconnecting means or overcurrent device to the grounding electrode side of the impedance grounding device.

(2) Size.

Impedance bonding jumpers shall be sized in accordance with 250.36(B).

Submitter Information Verification

Committee: NEC-P05

Submittal Date: Tue Oct 22 11:26:56 EDT 2024

Committee Statement

Committee Statement: Charging text was added to 250.36(E) to introduce the subdivision and provide usability.

Response Message: SR-8240-NFPA 70-2024

Public Comment No. 440-NFPA 70-2024 [Section No. 250.36(E)]

Second Revision No. 8138-NFPA 70-2024 [Section No. 250.52(A)(3)]

(3) Concrete-Encased Electrodes.

Concrete-encased electrodes shall consist of at least 6.0 m (20 ft) of either of the following:

(1) One or more bare or zinc galvanized or other electrically conductive coated rebar of not less than 13 mm (½ in.) in diameter, installed in one continuous 6.0 m (20 ft) length, or if in multiple pieces, connected together by steel tie wires, exothermic welding, welding, or other effective means to create a 6.0 m (20 ft) or greater length

(2) Bare copper conductor not smaller than 4 AWG

Metal components shall be encased by at least 50 mm (2 in.) of concrete and be located horizontally within that portion of a concrete foundation or footing that is in direct contact with the earth or within vertical foundations or structural components or members that are in direct contact with the earth. If multiple concrete-encased electrodes are present at a building or structure, bonding only one into the grounding electrode system shall be permitted.

Informational Note: ~~Concrete installed with~~ Direct contact with the earth is hindered by insulation, vapor barriers, films, or similar items ~~separating~~ that separate the concrete from the earth~~ is not considered to be in "direct contact" with the earth~~ .

Supplemental Information

File Name	Description	Approved
NEC_CMP-5_SR-8138_250.52_A_3_.docx		

Submitter Information Verification

Committee: NEC-P05

Submittal Date: Mon Oct 21 12:53:41 EDT 2024

Committee Statement

Committee Statement: The informational note was restored with revised language to provide examples to assist users in understanding the concept of direct contact with the earth.

Response Message: SR-8138-NFPA 70-2024

Public Comment No. 429-NFPA 70-2024 [Section No. 250.52(A)(3)]

Public Comment No. 1169-NFPA 70-2024 [Section No. 250.52(A)(3)]

(3) Concrete-Encased Electrodes.

Concrete-encased electrodes shall consist of at least 6.0 m (20 ft) of either of the following:

1. One or more bare or zinc galvanized or other electrically conductive coated rebar of not less than 13 mm (1⁄2 in.) in diameter, installed in one continuous 6.0 m (20 ft) length, or if in multiple pieces, connected together by steel tie wires, exothermic welding, welding, or other effective means to create a 6.0 m (20 ft) or greater length
2. Bare copper conductor not smaller than 4 AWG

Metal components shall be encased by at least 50 mm (2 in.) of concrete and be located horizontally within that portion of a concrete foundation or footing that is in direct contact with the earth or within vertical foundations or structural components or members that are in direct contact with the earth. If multiple concrete-encased electrodes are present at a building or structure, bonding only one into the grounding electrode system shall be permitted.

Informational Note: Direct contact with the earth is hindered by insulation, vapor barriers, films, or similar items that separate the concrete from the earth.

Commented [SB1]: IN was deleted at FD

Second Revision No. 8235-NFPA 70-2024 [Section No. 250.53(A)(4)]

(4) Rod and Pipe Electrodes.

Rod and pipe electrodes shall be installed in accordance with 250.53(A)(4)(a) through 250.53(A)(4)(c).

(a) Electrodes shall be installed such that at least 2.44 m (8 ft) of length is in contact with the soil.

(b) ~~If necessary, when rock bottom is encountered, electrodes shall comply with the following:~~ The electrode shall be driven ~~such that it is vertically in contact with the soil for a minimum length of 2.44 m (8 ft~~ vertically to a depth of not less than 2.44 m (8 ft).

(3)

Exception No. 1: If rock bottom is encountered, the electrode shall be permitted to be driven at an oblique angle not to exceed 45 degrees from the vertical.

Exception No. 2: If rock bottom is encountered at an angle up to 45 degrees, the electrode shall be permitted to be buried in a trench that is at least 750 mm (30 in.) deep.

(c) The upper end of the electrode shall be flush with or below ground level unless the aboveground end and the grounding electrode conductor attachment are protected against physical damage as specified in 250.10 .

Supplemental Information

File Name	Description	Approved
SR-8235_250.53_A_4_.docx	staff use	

Submitter Information Verification

Committee: NEC-P05

Submittal Date: Mon Oct 21 20:08:45 EDT 2024

Committee Statement

Committee Statement: A charging statement was added for usability. The section is revised to indicate that a rod or pipe electrode is first to be driven vertically to a depth of 8 feet and with the exceptions revised to clarify when it is permissible to drive at a 45-degree angle or to bury horizontally.

Response Message: SR-8235-NFPA 70-2024

Public Comment No. 430-NFPA 70-2024 [Section No. 250.53(A)(4)]

Public Comment No. 271-NFPA 70-2024 [Section No. 250.53(A)]

Second Revision No. 8151-NFPA 70-2024 [Section No. 250.64(D)(1)]

(1) Common Grounding Electrode Conductors and Taps.

Common grounding electrode conductors and grounding electrode conductor taps shall be installed ~~as permitted by~~ in accordance with 250.64(D)(1)(a) and 250.64(D)(1)(b).

(a) *Common Grounding Electrode Conductor*. Common grounding electrode conductors shall be sized in accordance with 250.66, based on the sum of the circular mil area of the largest ungrounded conductor(s) of each set of conductors that supplies the disconnecting means. If service-entrance conductors connect directly to overhead service conductors, service drop, underground service conductors, or service lateral, common grounding electrode conductors shall be sized in accordance with Table 250.66, Note 1.

(b) *Grounding Electrode Conductor Taps*. Grounding electrode conductor taps shall extend to the inside of each disconnecting means enclosureand be sized in accordance with 250.66 for the largest service-entrance or feeder conductor serving the individual enclosure. Tap conductors shall be connected to common grounding electrode conductors by one of the following methods such that the common grounding electrode conductor remains without a splice or joint:

(3) Exothermic welding

(4) Connectors listed as grounding and bonding equipment

(5) Connections to aluminum or copper busbarsas follows:

(6) Busbars shall be not less than 6 mm thick × 50 mm wide ($\frac{1}{4}$ in. thick × 2 in. wide) and of a length to accommodate the number of terminations necessary for the installation.

(7) Busbars shall be securely fastened and installed in an accessible location.

(8) Connections shall be made by listed connectors or by exothermic welding process.

(9) If aluminum busbars are used, installation shall comply with 250.64(A) .

Submitter Information Verification

Committee: NEC-P05
Submittal Date: Mon Oct 21 13:39:58 EDT 2024

Committee Statement

Committee Statement: The phrase “as permitted by” is replaced with “in accordance with” to use mandatory language and improve readability of the requirement.
Response Message: SR-8151-NFPA 70-2024

Public Comment No. 441-NFPA 70-2024 [Section No. 250.64(D)(1)]

Second Revision No. 8153-NFPA 70-2024 [Section No. 250.64(E)(1)]

(1) General.

Raceways, cable armor, and enclosures that contain grounding electrode conductors shall comply with either 250.64(E)(1)(a) or 250.64(E)(1)(b).

(a) Ferrous metal raceways, enclosures, and cable armor for grounding electrode conductors shall comply with the following:

~~They shall be~~

(1) Be electrically continuous from the point of attachment to cabinets or equipment to the grounding electrodes.

~~They shall be~~

(1) Be securely fastened to ground clamps or fittings.

~~They shall be~~

(1) Be bonded at each end of the raceway, cable armor, or enclosure to the grounding electrode or grounding electrode conductor to create an electrically parallel path.

(b) Nonferrous metal raceways, enclosures, and cable armor shall not be required to be electrically continuous.

Supplemental Information

File Name	Description	Approved
SR-8153_250.64_E_1_.docx	staff use	

Submitter Information Verification

Committee: NEC-P05

Submittal Date: Mon Oct 21 13:44:04 EDT 2024

Committee Statement

Committee Statement: Charging language was added for usability. The phrase “They shall” was removed in each numbered list item, as it was unnecessary, duplicative language.

Response Message: SR-8153-NFPA 70-2024

Public Comment No. 442-NFPA 70-2024 [Section No. 250.64(E)(1)]

Public Comment No. 1840-NFPA 70-2024 [Section No. 250.64(E)(1)]

Second Revision No. 8227-NFPA 70-2024 [Section No. 250.94(A)]

(A) Intersystem Bonding Termination (IBT) Devices.

Intersystem bonding termination (IBT) devices for connecting intersystem bonding conductors shall be provided external to enclosures at service equipment or metering equipment enclosures ~~, provided~~ or at the disconnecting means for any buildings or structures that are supplied by a feeder or branch circuit ~~,~~ and comply with the following:

(1) Be accessible for connection and inspection

(2) Consist of a set of terminals with the capacity for connection of not less than three intersystem bonding conductors

(3) Not interfere with opening the enclosure for a service, building or structure disconnecting means, or metering equipment

(4) Be securely mounted and connected as follows:

~~Connected to~~

a. To any of the following at the service equipment:

(5) Metal enclosure for the service equipment

(6) Metal meter enclosure

(7) Exposed nonflexible metal service raceway

(8) Metal enclosure for a grounding electrode conductor with a minimum 6 AWG copper conductor

~~Minimum~~

a.

i. The building or structure with a minimum 6 AWG copper grounding electrode conductor

~~attached to the building or structureConnected to~~

a.

i.

b. To any of the following at the disconnecting means for buildings or

~~structuressupplied~~

a. structures supplied by a feeder or branch circuit:

(9) Metal enclosure for the building or structure disconnecting means

(10) Metal enclosure for a grounding electrode conductor with a minimum 6 AWG copper conductor

~~Minimum~~

a.

i. The building or structure with a minimum 6 AWG copper grounding electrode conductor

~~attached to the building or structure~~

a.

i.

(11) Be listed as grounding and bonding equipment or as communications grounding and bonding equipment

Exception: In existing buildings or structures, if any of the intersystem bonding and grounding electrode conductors required by 750.~~114(B)(2)~~ ~~, 800.100(B)(2), 810.21(F)(2), or 820.100~~ 48 , 750.66, 750.100, or 800.48 exist, installation of an IBT shall not be required. An accessible means external to enclosures for connecting intersystem bonding and grounding electrode conductors shall be permitted at the service equipment and at the disconnecting means for any buildings or structures that are supplied by a feeder or branch circuit by at least one of the following means:

(1) Exposed nonflexible metal raceways

(2) Exposed grounding electrode conductors

(3) Approved means for the external connection of copper or other corrosion-resistant bonding or grounding electrode conductors to the grounded raceways or equipment

Informational Note: See 750.~~114~~ 48 , ~~800~~ 750 . ~~100~~ 66 , ~~810~~ 750 . ~~21~~ 100 , and ~~820~~ 800 . ~~100~~ 48 for intersystem bonding and grounding requirements for ~~conductive optical fiber cables, communications circuits, radio and television equipment, CATV circuits, and network-powered broadband communications systems, respectively~~ limited-energy systems .

Supplemental Information

File Name	Description	Approved
SR-8227_250.94_A_.docx	staff use	

Submitter Information Verification

Committee: NEC-P05

Submittal Date: Mon Oct 21 19:15:43 EDT 2024

Committee Statement

Committee Statement: Section 250.94(A) was revised for clarity and accuracy. An option for listing as communications grounding and bonding equipment was added in 250.94(A)(5) for accuracy. The references in the exception were corrected to correlate with the reorganization.

Response Message: SR-8227-NFPA 70-2024

Public Comment No. 431-NFPA 70-2024 [Section No. 250.94(A)]

Public Comment No. 1888-NFPA 70-2024 [Section No. 250.94(A)]

Public Comment No. 51-NFPA 70-2024 [Section No. 250.94(A)]

Second Revision No. 8309-NFPA 70-2024 [Section No. 250.109]

250.109 Metal and Nonmetallic Enclosures.

Metal enclosures shall be permitted as part of the effective ground-fault current path in accordance with 250.109(A). ~~Nonmetallic boxes and enclosures installed with metal wiring methods~~ Metal wiring methods used with nonmetallic boxes or enclosures shall be installed in accordance with 250.109(B).

(A) Metal Enclosures.

Metal enclosures shall comply with the following:

(1) Metal enclosures shall be permitted to be used to connect bonding jumpers or equipment grounding conductors, or both, together to become part of an effective ground-fault current path.

(2) If installed, metal covers, plaster rings, extension rings, and metal fittings shall be attached to metal enclosures ~~to~~ in a manner that will ensure an effective ground-fault current path or be connected with bonding jumpers or equipment grounding conductors, or both.

Informational Note: See 250.97 for bonding requirements for over 250 volts to ground.

(B) ~~–~~ Metal Wiring Methods Installed with Nonmetallic Boxes and Enclosures ~~Installed with Metallic Wiring Methods~~ .

Nonmetallic boxes and enclosures installed with metal ~~raceways or metal armored cable~~ wiring methods shall comply with 250.109(B)(1) and 250.109(B)(2).

(1) Bonding.

~~Metal covers installed on nonmetallic enclosures shall have equipment bonding jumpers or other bonding means installed from the metal covers to the bonding means provided for the metal raceways or cable armor.~~

~~Nonmetallic~~ Metal wiring methods installed with nonmetallic boxes and enclosures ~~using metal wiring methods~~ shall comply with one of the following:

(1) Listed nonmetallic boxes or enclosures with integral bonding means to interconnect all ~~metallic raceway or cable armor entries~~ metal wiring method connections or fittings and provide bonding for any metal covers installed shall not be required to have additional bonding means or equipment bonding jumpers installed.

(2) ~~Nonmetallic~~ Metal wiring methods used with nonmetallic boxes and enclosures ~~installed with metallic wiring methods~~ shall have an equipment bonding means and equipment bonding jumpers installed for each metal ~~raceway or metal armored cable entry~~ wiring method connection or fitting to ensure continuity of the metal wiring method and effective ground-fault current paths.

~~**(2)** Metal Covers.~~

Exception: A nonmetallic box or enclosure that is supplied by a single metal raceway or single cable with metal

~~armored cable~~

armor shall not be required to have additional bonding

~~where~~

if all the following conditions are met:

~~There are no other metal raceways or armored type cables entering~~

(1) No other metal wiring methods are connected to the box or enclosure.

(2) The

~~supply end of the metal raceway or metal armored cable~~

(1) metal wiring method is bonded in accordance with 250.86 .

~~There is a~~

(1) A wire-type equipment grounding conductor sized in accordance with 250.122 is installed in the metal

~~raceway or armored cable, or~~

(1) wiring method or an equipment bonding jumper attached to the metal

~~raceway or metal sheathed cable~~

(1) wiring method that complies with 250.118

~~;~~

(1) is connected to the equipment or

~~device~~

(1) devices in the nonmetallic box or enclosure to complete the effective ground-fault current path.

(2) The

~~conductors installed in the metal raceway or armored cable are not service conductors, grounding electrode conductors, or bonding jumpers interconnecting grounding electrodes.The~~

(1) installation complies with 314.29 for accessibility.

(2) Metal Covers.

Metal covers installed on nonmetallic enclosures shall be connected to the equipment grounding conductor or integral bonding means.

Supplemental Information

File Name	Description	Approved
250.109.docx	staff use	
250.109_SR-8309_CMP-5.docx	For prod use	

Submitter Information Verification

Committee: NEC-P05

Submittal Date: Wed Oct 23 11:42:08 EDT 2024

Committee Statement

Committee Statement: The term “metallic wiring methods” is changed to “metal wiring methods” to comply with the NEC Style Manual. Other editorial changes were made to improve clarity.

The use of the term “bonding jumper” is acceptable.

Response Message: SR-8309-NFPA 70-2024

Public Comment No. 1250-NFPA 70-2024 [Section No. 250.109(B)]

Public Comment No. 1856-NFPA 70-2024 [Section No. 250.109]

Second Revision No. 8311-NFPA 70-2024 [Section No. 250.118(A)]

(A) Permitted.

Each equipment grounding conductor run with or enclosing circuit conductors shall be one or more, or a combination of, the following as part of an effective ground-fault current path:

(1) A copper, aluminum, or copper-clad aluminum conductorthat is solid or stranded; insulated, covered, or bare; and in the form of a wire or a busbar of any shape

(2) Rigid metal conduit

(3) Intermediate metal conduit

(4) Electrical metallic tubing

(5) Listed flexible metal conduit meeting all the following conditions:

(6) The conduit is terminated in listed fittings.

(7) The circuit conductors contained in the conduit are protected by overcurrent devices rated at 20 amperes or less.

(8) The size of the conduit does not exceed metric designator 35 (trade size 1 1/4).

(9) The combined length of flexible metal conduit, flexible metallic tubing, and liquidtight flexible metal conduit in the same effective ground-fault current path does not exceed 1.8 m (6 ft).

(10) If flexibility is necessary to minimize the transmission of vibration from equipment or to provide flexibility for equipment that requires movement after installation, a wire-type equipment grounding conductor or a bonding jumper in accordance with 250.102(E)(2) is installed.

(11) If flexible metal conduit is constructed of stainless steel, a wire-type equipment grounding conductor or bonding jumper in accordance with 250.102(E)(2) is installed.

(12) Listed liquidtight flexible metal conduit meeting all the following conditions:

(13) The conduit is terminated in listed fittings.

(14) For metric designators 12 through 16 (trade sizes 3/8 through 1/2), the circuit conductors contained in the conduit are protected by overcurrent devices rated at 20 amperes or less.

(15) For metric designators 21 through 35 (trade sizes 3/4 through 1 1/4), the circuit conductors contained in the conduit are protected by overcurrent devices rated not more than 60 amperes and there is no flexible metal conduit, flexible metallic tubing, or liquidtight flexible metal conduit in metric designators 12 through 16 (trade sizes 3/8 through 1/2) in the effective ground-fault current path.

(16) The combined length of flexible metal conduit, flexible metallic tubing, and liquidtight flexible metal conduit in the same effective ground-fault current path does not exceed 1.8 m (6 ft).

(17) If flexibility is necessary to minimize the transmission of vibration from equipment or to provide flexibility for equipment that requires movement after installation, a wire-type equipment grounding conductor or a bonding jumper in accordance with 250.102(E)(2) is installed.

(18) If liquidtight flexible metal conduit contains a stainless steel core, a wire-type equipment grounding conductor or a bonding jumper in accordance with 250.102(E)(2) is installed.

(19) Flexible metallic tubing, if the tubing is terminated in listed fittings and meets the following conditions:

(20) The circuit conductors contained in the tubing are protected by overcurrent devices rated at 20 amperes or less.

(21) . The combined length of flexible metal conduit, flexible metallic tubing, and liquidtight flexible metal conduit in the same effective ground-fault current path does not exceed 1.8 m (6 ft).

(22) The tubing contains circuit conductors not exceeding 1000 V, nominal.

(23) Armor of Type AC cable as provided in 320.108 containing circuit conductors not exceeding 600 V, nominal

(24) Copper sheath of mineral-insulated, metal-sheathed cable Type MI containing circuit conductors not exceeding 600 V, nominal

(25) Type MC cable that provides an effective ground-fault current path in accordance with one or more of the following:

(26) It contains an insulated or uninsulated equipment grounding conductor complying with 250.118(A)(1) .

(27) The combined metallic sheath and uninsulated equipment grounding/bonding conductor of interlocked metal tape–type MC cable is listed and identified as an equipment grounding conductor.

(28) The metallic sheath or the combined metallic sheath and equipment grounding conductors of the smooth or corrugated tube-type MC cable is listed and identified as an equipment grounding conductor.

(29) Cable trays as permitted in 392.10 and 392.60

(30) Cablebus framework as permitted in 370.60(1)

(31) Other listed electrically continuous metal raceways and listed auxiliary gutters

(32) Surface metal raceways listed for grounding and containing circuit conductors not exceeding 600 V, nominal

Informational Note: See Article 100 for a definition of *effective ground-fault current path*.

Supplemental Information

File Name	Description	Approved
250.118_A_.docx	staff use	

Submitter Information Verification

Committee: NEC-P05

Submittal Date: Wed Oct 23 12:10:08 EDT 2024

Committee Statement

Committee Statement: This revision clarifies that not all wiring methods have been certified as equipment grounding conductors for voltages above 600 V or 1000 V per the applicable standards.

Response Message: SR-8311-NFPA 70-2024

Public Comment No. 1819-NFPA 70-2024 [Section No. 250.118(A)]

Second Revision No. 8360-NFPA 70-2024 [Section No. 250.122]

250.122 Size of Equipment Grounding Conductors ~~. - (~~

~~A~~

EGCs)

~~General~~

.

~~(1) Sizing.~~

Copper, aluminum, or copper-clad aluminum equipment grounding conductors of the wire type shall not be smaller than shown in Table 250.122 unless otherwise permitted by 250.122 (A) through 250 . 122(I).

(A) Not Larger Than Circuit Conductors .

Equipment grounding conductors shall not be required to be larger than the circuit conductors in the raceway or cable supplying the equipment.

(

~~2) Cable Trays~~

B) Other Than Wire Type EGCs .

Cable trays, raceways, or cable armor or sheaths used as equipment grounding conductors as provided in 250.118 (A) and 250.134 (1) shall comply with 250.4(A)(5) or 250.4(B)(4) .

(

~~3~~

C) Sectioned EGCs .

Equipment grounding conductors shall be permitted to be sectioned within multiconductor cables if the combined circular mil area complies with Table 250.122

~~(A)~~

.

(

~~B~~

D) Increased in Size.

If ungrounded conductors are increased in size for any reason other than as required in 310.15(B) or 310.15(C) , wire-type equipment grounding conductors, if installed, shall be increased in size proportionately to the increase in circular mil area of the ungrounded conductors.

Exception: Equipment grounding conductors shall be permitted to be sized by a qualified person to provide an effective ground fault current path in accordance with 250.4(A)(5) or 250.4(B)(4) .

(

~~C~~

E) Multiple Circuits.

A single equipment grounding conductor shall be permitted to be installed for multiple circuits that are installed in the same raceway, cable, trench, or cable tray. It shall be sized from Table 250.122

~~(A)~~

for the largest overcurrent device protecting circuit conductors in the raceway, cable, trench, or cable tray. Equipment grounding conductors installed in cable trays shall meet the minimum requirements of 392.10(B)(1)(c) .

(

~~D~~

F) Motor Circuits.

Equipment grounding conductors for motor circuits shall be sized in accordance with 250.122(D)(1) or 250.122(D)(2) .

(1) General.

The equipment grounding conductor size shall not be smaller than determined by 250.122(A) based on the rating of the branch-circuit short-circuit and ground-fault protective device.

(2) Instantaneous-Trip Circuit Breakers and Motor Short-Circuit Protectors.

If motor branch-circuit short-circuit and ground-fault protective devices are instantaneous-trip circuit breakers or motor short-circuit protectors, the equipment grounding conductors shall be sized not smaller than Table 250.122

~~(A)~~

using the maximum permitted rating of a dual element time-delay fuse selected for branch-circuit short-circuit and ground-fault protection in accordance with 430.52(C)(1) Exception No. 1.

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G) Flexible Cord and Fixture Wire.

The equipment grounding conductor in a flexible cord with the largest circuit conductor 10 AWG or smaller, and the equipment grounding conductor used with fixture wires of any size in accordance with 240.5 , shall not be smaller than 18 AWG copper and shall not be smaller than the circuit conductors. The equipment grounding conductor in a flexible cord with a circuit conductor larger than 10 AWG shall be sized in accordance with Table 250.122

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H) Conductors in Parallel.

For circuits of parallel conductors as permitted in 310.10(G) , equipment grounding conductors shall be installed in accordance with 250.122(F)(1) or 250.122(F)(2) .

(1) Conductor Installations in Raceways, Auxiliary Gutters, or Cable Trays.

(a) *Single Raceway*

~~or Cable Tray~~

(a) *, Auxiliary Gutter* , *or Cable Tray* . If circuit conductors are connected in parallel in the same raceway, auxiliary gutter, or cable tray, a single wire-type conductor sized in accordance with 250.122 based on the overcurrent protective device for the feeder or branch circuit shall be permitted as the equipment grounding conductor.

(b) *Multiple Raceways* . If conductors are installed in multiple raceways and are connected in parallel, a wire-type equipment grounding conductor, if used, shall be installed in each raceway, be connected in parallel, and comply with the following:

(3) The equipment grounding conductor installed in each raceway shall be sized in accordance with 250.122 based on the rating of the overcurrent protective device for the feeder or branch circuit.

(4) The equipment grounding conductor in each raceway shall not be required to be larger than the largest ungrounded conductor in the raceway.

(e) *Wire-Type Equipment Grounding Conductors in Cable Trays.* Wire-type equipment grounding conductors installed in cable trays shall meet the minimum requirements of 392.10(B)(1) (c).

(f) *Metal Raceways, Auxiliary Gutters, or Cable Trays.* Metal raceways or auxiliary gutters complying with 250.118 (A) or cable trays complying with 392.60(B) shall be permitted as equipment grounding conductors.

(2) Multiconductor Cables.

(a) Except as provided in 250.122(F)(2) (c) for raceway, trench, or cable tray installations, the equipment grounding conductor in each multiconductor cable shall be sized in accordance with 250.122 based on the overcurrent protective device for the feeder or branch circuit.

(b) If circuit conductors of multiconductor cables are connected in parallel, the equipment grounding conductor(s) in each cable shall be connected in parallel.

(c) If multiconductor cables are paralleled in the same raceway, auxiliary gutter, trench, or cable tray, a single equipment grounding conductor that is sized in accordance with 250.122 shall be permitted in combination with the equipment grounding conductors provided within the multiconductor cables and shall all be connected together.

(d) Equipment grounding conductors installed in cable trays shall meet the minimum requirements of 392.10(B)(1) (c). Cable trays complying with 392.60(B) , metal raceways complying with 250.118 (A) , or auxiliary gutters shall be permitted as equipment grounding conductors.

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I) Feeder Taps.

Equipment grounding conductors installed with feeder taps shall not be smaller than shown in Table 250.122

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based on the rating of the overcurrent device ahead of the feeder on the supply side ahead of the tap but shall not be required to be larger than the tap conductors.

Table 250.122

~~(A) Minimum~~

Minimum Size Equipment Grounding Conductors for Grounding Raceway and Equipment

Rating or Setting of Automatic Overcurrent Device in Circuit Ahead of Equipment, Conduit, etc., Not Exceeding (Amperes)	Size (AWG or kcmil)	
	Copper	Aluminum or Copper-Clad Aluminum*
15	14	12
20	12	10
60	10	8
100	8	6
200	6	4
300	4	2
400	3	1
500	2	1/0
600	1	2/0
800	1/0	3/0
1000	2/0	4/0
1200	3/0	250
1600	4/0	350
2000	250	400
2500	350	600
3000	400	600
4000	500	750
5000	700	1250
6000	800	1250

Note: Where necessary to comply with 250.4(A)(5) or (B)(4), the equipment grounding conductor shall be sized larger than given in this table.

*See installation restrictions in 250.120.

Supplemental Information

File Name	Description	Approved
250.122.docx	staff use	
250.122_SR-8360_CMP-5.docx	For prod use	

Submitter Information Verification

Committee: NEC-P05

Submittal Date: Thu Oct 24 12:03:23 EDT 2024

Committee Statement

Committee Statement: Section 250.122 and its subsections are revised for readability and to comply with the NEC Style Manual for formatting. No technical changes occurred as a result of this revision.

In the First Draft, Table 250.122 was renumbered as "Table 250.122(A)" to comply with the NEC Style Manual, which requires tables and figures to be numbered based the section/subdivision that first references it. The reorganization of 250.122 moves the first table reference from 250.122(A)(1) to the main paragraph (250.122), which returns the table to its original numbering.

The subsection (A) heading is deleted.

250.122(A)(1) is promoted to 250.122(A), and the title is revised to reflect the content of the subsection. The phrase “in the raceway or cable” is added to the remaining sentence to clarify that if circuit conductors are installed in parallel in a single raceway, the equipment grounding conductor is to be based on the rating of the overcurrent circuit protective device but does not have to be larger than the equivalent size of the sum of the individual phase conductors. Parallel circuit conductors in multiple raceways or cables are sized based on 250.122(F).

250.122(A)(2) is promoted to 250.122(B), and the title is revised to reflect the content of the subsection.

250.122(A)(3) is promoted to 250.122(C), and the title is revised to reflect the content of the subsection.

The title of 250.122(F)(1) [renumbered as 250.122(H)(1) due to the changes in 250.122(A)] is revised to eliminate redundant terms.

Response Message: SR-8360-NFPA 70-2024

Public Comment No. 1252-NFPA 70-2024 [Section No. 250.122(A)(2)]

Public Comment No. 1870-NFPA 70-2024 [Section No. 250.122(G)]

Public Comment No. 153-NFPA 70-2024 [Section No. 250.122(A)(1)]

Public Comment No. 1868-NFPA 70-2024 [Section No. 250.122(A)]

Second Revision No. 8314-NFPA 70-2024 [Article 270]

Article 270 Grounding and Bonding of Systems over 1000 Volts ac, 1500 Volts dc, Nominal [SEE ATTACHED FOR CHANGES]

Part I. General

270.1 Scope.

This article covers general requirements for grounding and bonding of electrical installations over 1000 volts ac, 1500 volts dc, nominal and the following specific requirements:

(1) Systems, circuits, and equipment required or permitted to be grounded

(2) Circuit conductor to be grounded on grounded systems

(3) Location of grounding connections

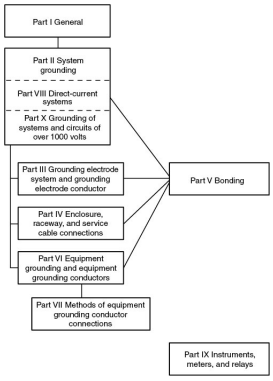
(4) Types and sizes of grounding and bonding conductors and electrodes

(5) Methods of grounding and bonding

(6) Conditions under which isolation, insulation, or guards are permitted to be substituted for grounding

Informational Note: See Figure Informational Note 270.1 for information on the organization of this article covering grounding and bonding requirements.

Figure Informational Note 270.1 Grounding and Bonding.



270.4 General Requirements for Grounding and Bonding.

The general requirements of this section shall identify what grounding and bonding of electrical systems are required to accomplish. The prescriptive methods contained in this article shall be followed to comply with the performance requirements of this section.

(A) Grounded Systems.

(1) Electrical System Grounding.

Electrical systems that are grounded shall be connected to earth in a manner that will limit the voltage imposed by lightning, line surges, or unintentional contact with higher-voltage lines and that will stabilize the voltage to earth during normal operation. A system neutral point derived from a grounding transformer shall be permitted to be used for grounding systems.

> Informational Note No. 1: An important consideration for limiting the imposed voltage is the routing of bonding and grounding electrode conductors so that they are not any longer than necessary to complete the connection without disturbing the permanent parts of the installation and so that unnecessary bends and loops are avoided.
>
> Informational Note No. 2: See NFPA 780-2020, *Standard for the Installation of Lightning Protection Systems*, for information on installation of grounding and bonding for lightning protection systems.

(2) Grounding of Electrical Equipment.

Normally non-current-carrying conductive materials enclosing electrical conductors or equipment, or forming part of such equipment, shall be connected to earth so as to limit the voltage to ground on these materials.

(3) Bonding of Electrical Equipment.

Normally non-current-carrying conductive materials enclosing electrical conductors or equipment, or forming part of such equipment, shall be connected together and to the electrical supply source in a manner that establishes an effective ground-fault current path.

(4) Bonding of Electrically Conductive Materials and Other Equipment.

Normally non-current-carrying electrically conductive materials that are likely to become energized shall be connected together and to the electrical supply source in a manner that establishes an effective ground-fault current path.

(5) Effective Ground-Fault Current Path.

Electrical equipment and wiring and other electrically conductive material likely to become energized shall be installed in a manner that creates a low-impedance circuit facilitating the operation of the overcurrent device or ground detector for impedance grounded systems. It shall be capable of safely carrying the maximum ground-fault current likely to be imposed on it from any point on the wiring system where a ground fault occurs to the electrical supply source. The earth shall not be considered as an effective ground-fault current path.

(B) Ungrounded Systems.

(1) Grounding Electrical Equipment.

Non-current-carrying conductive materials enclosing electrical conductors or equipment, or forming part of such equipment, shall be connected to earth in a manner that will limit the voltage imposed by lightning or unintentional contact with higher-voltage lines and limit the voltage to ground on these materials.

> Informational Note: See NFPA 780-2020, *Standard for the Installation of Lightning Protection Systems*, for information on installation of grounding and bonding for lightning protection systems.

(2) Bonding of Electrical Equipment.

Non-current-carrying conductive materials enclosing electrical conductors or equipment, or forming part of such equipment, shall be connected together and to the supply system grounded equipment in a manner that creates a low-impedance path for ground-fault current that is capable of carrying the maximum fault current likely to be imposed on it.

(3) Bonding of Electrically Conductive Materials and Other Equipment.

Electrically conductive materials that are likely to become energized shall be connected together and to the supply system grounded equipment in a manner that creates a low-impedance path for ground-fault current that is capable of carrying the maximum fault current likely to be imposed on it.

(4) Path for Fault Current.

Electrical equipment, wiring, and other electrically conductive material likely to become energized shall be installed in a manner that creates a low-impedance circuit from any point on the wiring system to the electrical supply source to facilitate the operation of overcurrent devices should a second ground fault from a different phase occur on the wiring system. The earth shall not be considered as an effective fault-current path.

270.6 Objectionable Current.

(A) Arrangement to Prevent Objectionable Current.

The grounding and bonding of electrical systems, circuit conductors, surge arresters, surge-protective devices, and conductive normally non-current-carrying metal parts of equipment shall be installed and arranged in a manner that will prevent objectionable current.

(B) Alterations to Stop Objectionable Current.

If the use of multiple grounding or bonding connections results in objectionable current and the requirements of 270.4(A)(5) or 270.4(B)(4) are met, one or more of the following alterations shall be permitted:

(1) Discontinue one or more but not all of such grounding or bonding connections.

(2) Change the locations of the grounding or bonding connections.

(3) Interrupt the continuity of the conductor or conductive path causing the objectionable current.

(4) Take other remedial and approved action.

(C) Currents Not Classified as Objectionable Currents.

Currents resulting from abnormal conditions such as ground faults, and from currents resulting from required grounding and bonding connections shall not be classified as objectionable currents for the purposes specified in 270.6(A) and 270.6(B).

(D) Limitations to Permissible Alterations.

This section shall not be considered as permitting electronic equipment to be operated on ac systems or branch circuits that are not connected to an equipment grounding conductor as required by this article. Currents that introduce electromagnetic interference or data errors in electronic equipment shall not be considered the objectionable currents addressed in this section.

(E) Isolation of Objectionable Direct Current from Cathodic Protection Systems.

If isolation of objectionable direct currents from a cathodic protection system is required, a listed isolator device shall be permitted in the equipment grounding conductor path to provide an effective return path for ac ground-fault current while blocking the flow of direct currents.

270.8 Connection of Grounding and Bonding Equipment.

(A) Permitted Methods.

Equipment grounding conductors, grounding electrode conductors, and bonding jumpers shall be connected by one or more of the following means:

(1) Listed pressure connectors

(2) Terminal bars

(3) Pressure connectors listed as grounding and bonding equipment

(4) Exothermic welding process

(5) Machine screw-type fasteners that engage not less than two threads or are secured with a nut

(6) Thread-forming machine screws that engage not less than two threads in the enclosure

(7) Connections that are part of a listed assembly

(8) Other listed means

(B) Methods Not Permitted.

Connection devices or fittings that depend solely on solder shall not be used.

270.10 Protection of Ground Clamps and Fittings.

Ground clamps or other fittings exposed to physical damage shall be enclosed in metal, wood, or equivalent protective covering.

270.12 Clean Surfaces.

Nonconductive coatings (such as paint, lacquer, and enamel) on equipment to be grounded or bonded shall be removed from threads and other contact surfaces to ensure electrical continuity or shall be connected by means of fittings designed to make such removal unnecessary.

270.13 Grounding System at Alternating-Current Substations.

For ac substations, the grounding system shall be in accordance with Article 270, Part III.

> Informational Note: See IEEE 80, *IEEE Guide for Safety in AC Substation Grounding*, for further information on outdoor ac substation grounding.

270.14 Grounding and Bonding of Fences and Other Metal Structures.

Metal fences enclosing, and other metal structures in or surrounding, a substation with exposed electrical conductors and equipment shall be grounded and bonded to limit step, touch, and transfer voltages.

(A) Metal Fences.

If metal fences are located within 5 m (16 ft) of the exposed electrical conductors or equipment, the fence shall be bonded to the grounding electrode system with wire-type bonding jumpers as follows:

(1) Bonding jumpers shall be installed at each fence corner and at maximum 50 m (160 ft) intervals along the fence.

(2) If bare overhead conductors cross the fence, bonding jumpers shall be installed on each side of the crossing.

(3) Gates shall be bonded to the gate support post, and each gate support post shall be bonded to the grounding electrode system.

(4) Any gate or other opening in the fence shall be bonded across the opening by a buried bonding jumper.

(5) The grounding grid or grounding electrode systems shall be extended to cover the swing of all gates.

(6) The barbed wire strands above the fence shall be bonded to the grounding electrode system.

Alternate designs performed under engineering supervision shall be permitted for grounding or bonding of metal fences.

> Informational Note No. 1: A nonconducting fence or section may provide isolation for transfer of voltage to other areas.
>
> Informational Note No. 2: See IEEE 80, *IEEE Guide for Safety In AC Substation Grounding,* for design and installation of fence grounding.

(B) Metal Structures.

All exposed conductive metal structures, including guy wires within 2.5 m (8 ft) vertically or 5 m (16 ft) horizontally of exposed conductors or equipment and subject to contact by persons, shall be bonded to the grounding electrode systems in the area.

Part II. System Grounding

270.20 Alternating-Current Systems to Be Grounded.

Alternating-current systems shall be grounded in accordance with 270.20(A) or 270.20(B), unless prohibited elsewhere in this code. Other systems shall be permitted to be grounded. If such systems are grounded, they shall comply with the applicable requirements of this article.

Informational Note: An example of a system permitted to be grounded is a corner-grounded delta transformer connection.

(A) Alternating-Current Systems.

Alternating-current systems supplying mobile or portable equipment shall be grounded in accordance with 270.115. If supplying other than mobile or portable equipment, such systems shall be permitted to be grounded.

(B) Impedance Grounded Systems.

Impedance grounded systems shall be grounded in accordance with 270.36.

270.21 Alternating-Current Systems Not Required to Be Grounded.

(A) General.

The following ac systems shall be permitted to be grounded but shall not be required to be grounded:

(1) Electrical systems used exclusively to supply industrial electric furnaces used for applications such as melting, refining, or tempering

(2) Separately derived systems used exclusively for rectifiers that supply only adjustable-speed industrial drives

(B) Ground Detectors.

Ground detectors shall be installed in accordance with the following:

(1) Ungrounded ac systems as permitted in 270.21(A)(1) through 270.21(A)(2) shall have ground detectors installed on the system.

(2) The ground detection sensing equipment shall be connected as close as practicable to where the system receives its supply.

(C) Marking.

Ungrounded systems shall be legibly marked “Caution: Ungrounded System Operating — Volts Between Conductors” at the source or first disconnecting means of the system. The marking shall be of sufficient durability to withstand the environment involved.

270.24 Grounding Service-Supplied Alternating-Current Systems.

(A) Systems with a Grounded Conductor at the Service Point.

If an ac system is grounded at any point and is provided with a grounded conductor at the service point, a grounded conductor(s) shall be installed and routed with the ungrounded conductors to each service disconnecting means and shall be connected to each disconnecting means grounded conductor(s) terminal or bus. A main bonding jumper shall connect the grounded conductor(s) to each service disconnecting means enclosure. The grounded conductor(s) shall be installed in accordance with 270.24(A)(1) through 270.24(A)(4). The size of the solidly grounded circuit conductor(s) shall be the larger of that determined by 270.27, 270.24(A)(1), or 270.24(A)(2).

Exception: If two or more service disconnecting means are located in a single assembly listed for use as service equipment, it shall be permitted to connect the grounded conductor(s) to the assembly common grounded conductor(s) terminal or bus. The assembly shall include a main bonding jumper for connecting the grounded conductor(s) to the assembly enclosure.

(1) Sizing for a Single Raceway or Overhead Conductor.

The grounded conductor shall not be smaller than the required grounding electrode conductor specified in Table 270.102(C)(1) but shall not be required to be larger than the largest ungrounded service-entrance conductor(s).

(2) Parallel Conductors in Two or More Raceways or Overhead Conductors.

If the ungrounded service-entrance conductors are installed in parallel in two or more raceways or as overhead parallel conductors, the grounded conductors shall also be installed in parallel. The size of the grounded conductor in each raceway or overhead shall be based on the total circular mil area of the parallel ungrounded conductors in the raceway or overhead, as indicated in 270.24(A)(1), but not smaller than 1/0 AWG.

Informational Note: See 310.10(G) for grounded conductors connected in parallel.

(3) Delta-Connected Service.

The grounded conductor of a 3-phase, 3-wire delta service shall have an ampacity not less than that of the ungrounded conductors.

(4) Impedance Grounded Systems.

Impedance grounded systems shall be installed in accordance with 270.36.

(B) Systems Without a Grounded Conductor at the Service Point.

If an ac system is grounded at any point and is not provided with a grounded conductor at the service point, a supply-side bonding jumper shall be installed and routed with the ungrounded conductors to each service disconnecting means and shall be connected to each disconnecting means equipment grounding conductor terminal or bus. The supply-side bonding jumper shall be installed in accordance with 270.24(B)(1) through 270.24(B)(3).

Exception: If two or more service disconnecting means are located in a single assembly listed for use as service equipment, it shall be permitted to connect the supply-side bonding jumper to the assembly common equipment grounding terminal or bus.

(1) Sizing for a Single Raceway or Overhead Conductor.

The supply-side bonding jumper shall not be smaller than the required grounding electrode conductor specified in Table 270.102(C)(1) but shall not be required to be larger than the largest ungrounded service-entrance conductor(s).

(2) Parallel Conductors in Two or More Raceways or Overhead Conductors.

If the ungrounded service-entrance conductors are installed in parallel in two or more raceways or overhead conductors, the supply-side bonding jumper shall also be installed in parallel. The size of the supply-side bonding jumper in each raceway or overhead shall be based on the total circular mil area of the parallel ungrounded conductors in the raceway or overhead, as indicated in 270.24(A)(1), but not smaller than 1/0 AWG.

(3) Impedance Grounded Systems.

Impedance grounded systems shall be installed in accordance with 270.36.

270.25 Grounding of Systems Permitted to Be Connected on the Supply Side of the Service Disconnect.

The grounding of systems connected on the supply side of the service disconnect, in accordance with 230.82, that are in enclosures separate from the service equipment enclosure shall comply with 270.25(A) or 270.25(B).

(A) Grounded System.

If the utility supply system is grounded, the grounding of systems permitted to be connected on the supply side of the service disconnect and are installed in one or more separate enclosures from the service equipment enclosure shall comply with the requirements of 270.24(A) through 252.24(D).

(B) Ungrounded Systems.

If the utility supply system is ungrounded, the grounding of systems permitted to be connected on the supply side of the service disconnect and are installed in one or more separate enclosures from the service equipment enclosure shall comply with the requirements of 252.24(F).

270.26 Conductor to Be Grounded — Alternating-Current Systems.

If an ac premises wiring system is grounded, the conductor to be grounded shall be one of the following:

(1) Single-phase, 2-wire — one conductor

(2) Single-phase, 3-wire — the neutral conductor

(3) Multiphase systems having one wire common to all phases — the neutral conductor

(4) Multiphase systems if one phase is grounded — that phase conductor

270.27 Solidly Grounded Neutral Systems.

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

(A) Neutral Conductor.

(1) Insulation Level.

The minimum insulation level for neutral conductors of solidly grounded systems shall be 600 volts.

Exception No. 1: For multigrounded neutral systems as permitted in 270.27(C), bare copper conductors shall be permitted to be used for the neutral conductor of the following:

(1) Service-entrance conductors

(2) Service laterals or underground service conductors

(3) Direct-buried portions of feeders

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

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

(2) Ampacity.

The neutral conductor shall have an ampacity that is not less than the load imposed and be not less than 33⅓ percent of the ampacity of the phase conductors.

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

(B) Single-Point Grounded Neutral System.

If a single-point grounded neutral system is used, the following shall apply:

(1) A single-point grounded neutral system shall be permitted to be supplied from one of the following:

(2) A separately derived system

(3) A multigrounded neutral system with an equipment grounding conductor connected to the multigrounded neutral conductor at the source of the single-point grounded neutral system

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

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

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

(7) An equipment grounding conductor shall be provided to each building, structure, and equipment enclosure.

(8) A neutral conductor shall only be required if phase-to-neutral loads are supplied.

(9) The neutral conductor, if provided, shall be insulated and isolated from earth except at one location.

(10) An equipment grounding conductor shall be run with the phase conductors and shall comply with all of the following:

(11) The ECG shall not carry continuous load.

(12) The ECG shall be bare, covered, or insulated.

(13) The ECG shall have ampacity for fault current duty.

(C) Multigrounded Neutral Systems.

If a multigrounded neutral system is used, the following shall apply:

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

(2) Transformers supplying conductors to a building or other structure

(3) Underground circuits if the neutral conductor is exposed

(4) Overhead circuits installed outdoors

(5) The multigrounded neutral conductor shall be grounded at each transformer and at other additional locations by connection to a grounding electrode.

(6) At least one grounding electrode shall be installed and connected to the multigrounded neutral conductor every 400 m (1300 ft).

(7) The maximum distance between any two adjacent electrodes shall not be more than 400 m (1300 ft).

(8) In a multigrounded shielded cable system, the shielding shall be grounded at each cable joint that is exposed to personnel contact.

Exception: In a multipoint grounded system, a grounding electrode shall not be required to bond the neutral conductor in an uninterrupted conductor exceeding 400 m (1300 ft) if the only purpose for removing the cable jacket is for bonding the neutral conductor to a grounding electrode.

270.28 Main Bonding Jumper and System Bonding Jumper.

For a grounded system, main bonding jumpers and system bonding jumpers shall be installed in accordance with 270.28(A) through 270.28(D).

(A) Material.

Main bonding jumpers and system bonding jumpers shall be of copper, aluminum, copper-clad aluminum, or other corrosion-resistant material. A main bonding jumper and a system bonding jumper shall be a wire, bus, screw, or similar suitable conductor.

(B) Construction.

If a main bonding jumper or a system bonding jumper is a screw only, the screw shall be identified with a green finish that shall be visible with the screw installed.

(C) Attachment.

Main bonding jumpers and system bonding jumpers shall be connected by one or more of the methods in 270.8 that is suitable for the material of the bonding jumper and enclosure.

(D) Size.

Main bonding jumpers and system bonding jumpers shall be sized in accordance with 270.28(D)(1) through 270.28(D)(3).

(1) General.

Main bonding jumpers and system bonding jumpers shall not be smaller than specified in Table 270.102(C)(1).

(2) Main Bonding Jumper for Service with More Than One Enclosure.

If a service consists of more than a single enclosure as permitted in 230.71(B), the main bonding jumper for each enclosure shall be sized in accordance with 270.28(D)(1) based on the largest ungrounded service conductor serving that enclosure.

(3) Separately Derived System with More Than One Enclosure.

If a separately derived system supplies more than a single enclosure, the system bonding jumper for each enclosure shall be sized in accordance with 270.28(D)(1) based on the largest ungrounded feeder conductor serving that enclosure, or a single system bonding jumper shall be installed at the source and sized in accordance with 270.28(D)(1) based on the equivalent size of the largest supply conductor determined by the largest sum of the areas of the corresponding conductors of each set.

270.30 Grounding Separately Derived Alternating-Current Systems.

In addition to complying with 270.30(A) for grounded systems, or as provided in 270.30(B) for ungrounded systems, separately derived systems shall comply with 270.20, 270.21, or 270.26, as applicable. Multiple power sources of the same type that are connected in parallel to form one system that supplies premises wiring shall be treated as a single separately derived system and shall be installed in accordance with 270.30.

> Informational Note No. 1: An alternate ac power source, such as an on-site generator, is not a separately derived system if the grounded conductor is solidly interconnected to a service-supplied system grounded conductor. An example of such a situation is if the alternate source transfer equipment does not include a switching action in the grounded conductor and allows it to remain solidly connected to the service-supplied grounded conductor when the alternate source is operational and supplying the load served.
>
> Informational Note No. 2: See 445.13 for the minimum size of conductors that carry fault current.

(A) Grounded Systems.

A separately derived ac system that is grounded shall comply with 270.30(A)(1) through 270.30(A)(8). Except as otherwise permitted in this article, a grounded conductor shall not be connected to normally non-current-carrying metal parts of equipment, be connected to equipment grounding conductors, or be reconnected to ground on the load side of the system bonding jumper.

Informational Note: See 270.32 for connections at separate buildings or structures and 270.142 for use of the grounded circuit conductor for grounding equipment.

Exception: Impedance grounded system grounding connections shall be made in accordance with 270.36.

(1) System Bonding Jumper.

An unspliced system bonding jumper shall comply with 270.28(A) through 270.28(D). This connection shall be made at any single point on the separately derived system from the source to the first system disconnecting means or overcurrent device, or it shall be made at the source of a separately derived system that has no disconnecting means or overcurrent devices, in accordance with 270.30(A)(1)(a) or 270.30(A)(1)(b). The system bonding jumper shall remain within the enclosure where it originates. If the source is located outside the building or structure supplied, a system bonding jumper shall be installed at the grounding electrode connection in compliance with 270.30(C).

(a) *Installed at the Source*. The system bonding jumper shall connect the grounded conductor to the supply-side bonding jumper and the normally non-current-carrying metal enclosure.

(b) *Installed at the First Disconnecting Means*. The system bonding jumper shall connect the grounded conductor to the supply-side bonding jumper, the disconnecting means enclosure, and the equipment grounding conductor(s).

Exception No. 1: For parallel sources or systems, a single system bonding jumper connection to the tie point of the grounded circuit conductors from each power source shall be permitted.

Exception No. 2: If a building or structure is supplied by a feeder from an outdoor separately derived system, a system bonding jumper at both the source and the first disconnecting means shall be permitted if doing so does not establish a parallel path for the grounded conductor. If a grounded conductor is used in this manner, it shall not be smaller than the size specified for the system bonding jumper but shall not be required to be larger than the ungrounded conductor(s). For the purposes of this exception, connection through the earth shall not be considered as providing a parallel path.

Exception No. 3: Separately derived systems consisting of multiple sources of the same type that are connected in parallel shall be permitted to have the system bonding jumper installed at the paralleling switchgear, switchboard, or other paralleling connection point instead of at the disconnecting means located at each separate source.

(2) Supply-Side Bonding Jumper.

If the source of a separately derived system and the first disconnecting means are located in separate enclosures, a supply-side bonding jumper shall be installed with the circuit conductors from the source enclosure to the first disconnecting means enclosure. A supply-side bonding jumper shall not be required to be larger than the derived ungrounded conductors. The supply-side bonding jumper shall be permitted to be of nonflexible metal raceway type or of the wire or bus type as follows:

(1) A supply-side bonding jumper of the wire type shall comply with 270.102(C), based on the size of the derived ungrounded conductors.

(2) A supply-side bonding jumper of the bus type shall have a cross-sectional area not smaller than a supply-side bonding jumper of the wire type as determined in 270.102.

Exception: A supply-side bonding jumper shall not be required between enclosures for installations made in compliance with 270.30(A)(1) Exception No. 2.

(3) Grounded Conductor.

If a grounded conductor is installed and the system bonding jumper connection is not located at the source, 270.30(A)(3)(a) through 270.30(A)(3)(d) shall apply. The grounded conductor shall not be required to be larger than the derived ungrounded conductors.

(a) *Sizing for a Single Raceway*. The grounded conductor shall not be smaller than specified in Table 270.102(C)(1).

(b) *Conductors Connected in Parallel in Two or More Raceways or Cables*. If the ungrounded conductors are connected in parallel in two or more raceways or cables, the grounded conductors shall also be installed in each raceway or cable and shall be connected in parallel. The size of the grounded conductor(s) in each raceway or cable shall be based on the largest derived ungrounded conductor in each raceway or cable, or the sum of the circular mil areas of the largest derived ungrounded conductors from each set connected in parallel in each raceway or cable, in accordance with 270.30(A)(3)(a), but not smaller than 1/0 AWG.

Informational Note: See 310.10(G) for grounded conductors connected in parallel.

(c) *Delta-Connected System*. The grounded conductor of a 3-phase, 3-wire delta system shall have an ampacity not less than that of the ungrounded conductors.

(d) *Impedance Grounded System*. The impedance grounding conductor of an impedance grounded system shall be installed in accordance with 270.36.

(4) Grounding Electrode.

The building or structure grounding electrode system shall be used as the grounding electrode for the separately derived system. If located outdoors, the grounding electrode shall be in accordance with 270.30(C).

Exception: If a separately derived system originates in equipment that is listed and identified as suitable for use as service equipment, the grounding electrode used for the service or feeder equipment shall be permitted to be used as the grounding electrode for the separately derived system.

Informational Note No. 1: See 270.104(D) for bonding requirements for interior metal water piping in the area served by separately derived systems.

Informational Note No. 2: See 270.50 and 270.58 for requirements for bonding all electrodes together if located at the same building or structure.

(5) Grounding Electrode Conductor, Single Separately Derived System.

A grounding electrode conductor for a single separately derived system shall be sized in accordance with 270.66 for the derived ungrounded conductors. It shall be used to connect the grounded conductor of the derived system to the grounding electrode in accordance with 270.30(A)(4), or as permitted in 270.68(C)(1) and 270.68(C)(2). This connection shall be made at the same point on the separately derived system where the system bonding jumper is connected.

Exception No. 1: If the system bonding jumper specified in 270.30(A)(1) is a wire or busbar, it shall be permitted to connect the grounding electrode conductor to the equipment grounding terminal, bar, or bus if the equipment grounding terminal, bar, or bus is of sufficient size for the separately derived system.

Exception No. 2: If the source of a separately derived system is located within equipment listed and identified as suitable for use as service equipment, the grounding electrode conductor from the service or feeder equipment to the grounding electrode shall be permitted as the grounding electrode conductor for the separately derived system if the grounding electrode conductor is of sufficient size for the separately derived system. If the equipment grounding bus internal to the equipment is not smaller than the required grounding electrode conductor for the separately derived system, the grounding electrode connection for the separately derived system shall be permitted to be made to the bus.

(6) Grounding Electrode Conductor, Multiple Separately Derived Systems.

A common grounding electrode conductor for multiple separately derived systems shall be permitted. If installed, the common grounding electrode conductor shall be used to connect the grounded conductor of each separately derived system to the grounding electrode as specified in 270.30(A)(4). A grounding electrode conductor tap shall then be installed from each separately derived system to the common grounding electrode conductor. Each tap conductor shall connect the grounded conductor of the separately derived system to the common grounding electrode conductor. This connection shall be made at the same point on the separately derived system where the system bonding jumper is connected.

Exception No. 1: If the system bonding jumper specified in 270.30(A)(1) is a wire or busbar, it shall be permitted to connect the grounding electrode conductor tap to the equipment grounding terminal, bar, or bus if the equipment grounding terminal, bar, or bus is of sufficient size for the separately derived system.

Exception No. 2: If the source of a separately derived system is located within equipment listed and identified as suitable for use as service equipment, the grounding electrode conductor from the service or feeder equipment to the grounding electrode shall be permitted as the grounding electrode conductor for the separately derived system if the grounding electrode conductor is of sufficient size for the separately derived system. If the equipment grounding bus internal to the equipment is not smaller than the required grounding electrode conductor for the separately derived system, the grounding electrode connection for the separately derived system shall be permitted to be made to the bus.

(a) *Common Grounding Electrode Conductor*. The common grounding electrode conductor shall be permitted to be one of the following:

(2) A conductor of the wire type not smaller than 3/0 AWG copper or 350 kcmil aluminum

(3) A metal water pipe in accordance with 270.68(C)(1)

(4) The metal structural frame of the building or structure in accordance with 270.68(C)(2) or is connected to the grounding electrode system by a conductor not smaller than 3/0 AWG copper or 350 kcmil aluminum

(e) *Tap Conductor Size.* Each tap conductor shall be sized in accordance with 270.66 based on the derived ungrounded conductors of the separately derived system it serves.

Exception to (A)(6)(a) and (A)(6)(b): If the only electrodes that are present are of the types in 270.66(A), 270.66(B), or 270.66(C), the size of the common grounding electrode conductor shall not be required to be larger than the largest conductor required by 270.66(A), 270.66(B), or 270.66(C) for the type of electrode that is present.

(f) *Connections*. All tap connections to the common grounding electrode conductor shall be made at an accessible location by one of the following methods:

(7) A connector listed as grounding and bonding equipment.

(8) Listed connections to aluminum or copper busbars not smaller than 6 mm thick × 50 mm wide (**1**⁄**4** in. thick × 2 in. wide) and of a length to accommodate the number of terminations necessary for the installation. If aluminum busbars are used, the installation shall also be in accordance with 270.64(A) .

(9) The exothermic welding process.

Tap conductors shall be connected to the common grounding electrode conductor in such a manner that the common grounding electrode conductor remains without a splice or joint.

(7) Installation.

The installation of all grounding electrode conductors shall comply with 270.64(A), 270.64(B), 270.64(C), and 270.64(E).

(8) Bonding.

Structural steel and metal piping shall be connected to the grounded conductor of a separately derived system in accordance with 252.104(D).

(B) Ungrounded Systems.

The equipment of an ungrounded separately derived system shall be grounded and bonded as specified in 270.30(B)(1) through 270.30(B)(3).

(1) Grounding Electrode Conductor.

A grounding electrode conductor, sized in accordance with 270.66 for the largest derived ungrounded conductor(s) or set of derived ungrounded conductors, shall be used to connect the metal enclosures of the derived system to the grounding electrode as specified in 270.30(A)(5) or 270.30(A)(6), as applicable. This connection shall be made at any point on the separately derived system from the source to the first system disconnecting means. If the source is located outside the building or structure supplied, a grounding electrode connection shall be made in compliance with 270.30(C).

(2) Grounding Electrode.

Except as permitted by 252.34 for portable and vehicle-mounted generators, the grounding electrode shall comply with 270.30(A)(4).

(3) Bonding Path and Conductor.

A supply-side bonding jumper shall be installed from the source of a separately derived system to the first disconnecting means in compliance with 270.30(A)(2).

(C) Outdoor Source.

If the source of the separately derived system is located outside the building or structure supplied, a grounding electrode connection shall be made at the source location to one or more grounding electrodes in accordance with 270.50. In addition, the installation shall be in accordance with 270.30(A) for grounded systems or with 270.30(B) for ungrounded systems.

Exception: The grounding electrode conductor connection for impedance grounded systems shall be in accordance with 270.36.

270.32 Buildings or Structures Supplied by a Feeder(s) or Branch Circuit(s).

(A) Grounding Electrode System and Grounding Electrode Conductor.

A building(s) or structure(s) supplied by a feeder(s) or branch circuit(s) shall have a grounding electrode system and grounding electrode conductor installed in accordance with Article 270, Part III.

Exception: A grounding electrode system and grounding electrode conductor shall not be required if only a single branch circuit, including a multiwire branch circuit, supplies the building or structure and the branch circuit includes an equipment grounding conductor for grounding the normally non-current-carrying metal parts of equipment.

(B) Grounded Systems.

(1) Supplied by a Feeder or Branch Circuit.

An equipment grounding conductor, as described in 270.118, shall be run with the supply conductors and be connected to the building or structure disconnecting means and to the grounding electrode(s). The equipment grounding conductor shall be used for grounding or bonding of equipment, structures, or frames required to be grounded or bonded. The equipment grounding conductor shall be sized in accordance with 270.122. Any installed grounded conductor shall not be connected to the equipment grounding conductor or to the grounding electrode(s).

Exception No. 1: For installations made in compliance with previous editions of this code that permitted such connection, the grounded conductor run with the supply to the building or structure shall be permitted to serve as the ground-fault return path if all of the following requirements continue to be met:

(1) An equipment grounding conductor is not run with the supply to the building or structure.

(2) There are no continuous metallic paths bonded to the grounding system in each building or structure involved.

(3) Ground-fault protection of equipment has not been installed on the supply side of the feeder(s).

If the grounded conductor is used for grounding in accordance with this exception, the size of the grounded conductor shall not be smaller than the larger of either of the following:

(1) The calculated neutral load in accordance with 120.61

(2) The minimum equipment grounding conductor sized in accordance with 270.122

Exception No. 2: If system bonding jumpers are installed in accordance with 270.30(A)(1) Exception No. 2, the feeder grounded circuit conductor at the building or structure served shall be connected to the equipment grounding conductors, grounding electrode conductor, and the enclosure for the first disconnecting means.

(2) Supplied by Separately Derived System.

(a) *With Overcurrent Protection*. If overcurrent protection is provided where the conductors originate, the installation shall comply with 270.32(B)(1).

(b) *Without Overcurrent Protection*. If overcurrent protection is not provided where the conductors originate, the installation shall comply with 270.30(A). If installed, the supply-side bonding jumper shall be connected to the building or structure disconnecting means and to the grounding electrode(s).

(C) Ungrounded Systems.

(1) Supplied by a Feeder or Branch Circuit.

An equipment grounding conductor, as described in 270.118, shall be installed with the supply conductors and be connected to the building or structure disconnecting means and to the grounding electrode(s). The grounding electrode(s) shall also be connected to the building or structure disconnecting means.

(2) Supplied by a Separately Derived System.

(a) *With Overcurrent Protection*. If overcurrent protection is provided where the conductors originate, the installation shall comply with 270.32(C)(1).

(b) *Without Overcurrent Protection*. If overcurrent protection is not provided where the conductors originate, the installation shall comply with 270.30(B). If installed, the supply-side bonding jumper shall be connected to the building or structure disconnecting means and to the grounding electrode(s).

(D) Disconnecting Means Located in Separate Building or Structure on the Same Premises.

If one or more disconnecting means supply one or more additional buildings or structures under single management, and where these disconnecting means are located remote from those buildings or structures in accordance with 225.31(B) Exceptions No. 1 and No. 2, 700.12(D)(4), 701.12(D)(3), or 702.12, all of the following conditions shall be met:

(1) The connection of the grounded conductor to the grounding electrode, to normally non-current-carrying metal parts of equipment, or to the equipment grounding conductor at a separate building or structure shall not be made.

(2) An equipment grounding conductor for grounding and bonding any normally non-current-carrying metal parts of equipment, interior metal piping systems, and building or structural metal frames is run with the circuit conductors to a separate building or structure and connected to existing grounding electrode(s) required in Article 270, Part III, or, if there are no existing electrodes, the grounding electrode(s) required in Article 270, Part III, shall be installed if a separate building or structure is supplied by more than one branch circuit.

(3) The connection between the equipment grounding conductor and the grounding electrode at a separate building or structure shall be made in a junction box, panelboard, or similar enclosure located immediately inside or outside the separate building or structure.

(E) Grounding Electrode Conductor.

The size of the grounding electrode conductor to the grounding electrode(s) shall not be smaller than given in 252.66, based on the largest ungrounded supply conductor. The installation shall comply with Article 270, Part III.

270.34 Portable, Vehicle-Mounted, and Trailer-Mounted Generators.

(A) Portable Generators.

The frame of a portable generator shall not be required to be connected to a grounding electrode as defined in 270.52 for a system supplied by the generator under both of the following conditions:

(1) The generator supplies only equipment mounted on the generator, cord-and-plug-connected equipment through receptacles mounted on the generator, or both.

(2) The normally non-current-carrying metal parts of equipment and the equipment grounding conductor terminals of the receptacles are connected to the generator frame.

(B) Vehicle-Mounted and Trailer-Mounted Generators.

The frame of a vehicle or trailer shall not be required to be connected to a grounding electrode as defined in 270.52 for a system supplied by a generator located on this vehicle or trailer under all of the following conditions:

(1) The frame of the generator is bonded to the vehicle or trailer frame.

(2) The generator supplies only equipment located on the vehicle or trailer; cord-and-plug-connected equipment through receptacles mounted on the vehicle; or both equipment located on the vehicle or trailer and cord-and-plug-connected equipment through receptacles mounted on the vehicle, trailer, or on the generator.

(3) The normally non-current-carrying metal parts of equipment and the equipment grounding conductor terminals of the receptacles are connected to the generator frame.

(C) Grounded Conductor Bonding.

A conductor that is required to be grounded by 270.26 shall be connected to the generator frame if the generator is a component of a separately derived system.

Informational Note: See 270.30 for grounding portable generators supplying fixed wiring systems.

270.35 Permanently Installed Generators.

A conductor that provides an effective ground-fault current path shall be installed with the supply conductors from a permanently installed generator(s) to the first disconnecting mean(s) in accordance with 270.35(A) or 270.35(B).

(A) Separately Derived System.

If the generator is installed as a separately derived system, the requirements in 270.30 shall apply.

(B) Nonintegral Overcurrent Protection.

If the generator is installed as a nonseparately derived system, and overcurrent protection is not integral with the generator assembly, a supply-side bonding jumper shall be installed between the generator equipment grounding terminal and the equipment grounding terminal, bar, or bus of the disconnecting mean(s) where the overcurrent protective device is located. It shall be sized in accordance with 270.102(C) based on the size of the conductors supplied by the generator.

270.36 Impedance Grounded Systems.

Impedance grounded systems in which a grounding impedance device, typically a resistor, limits the ground-fault current shall be permitted if all of the following conditions are met:

(1) The conditions of maintenance and supervision ensure that only qualified persons service the installation.

(2) Ground detectors are installed on the system.

(3) Line-to-neutral loads are not served.

Impedance grounded systems shall comply with 270.36(A) through 270.36(F).

(A) Location.

Grounding impedance devices shall be located as follows:

(1) Devices shall be installed between grounding electrode conductors and impedance grounding conductors connected to the system neutral point.

(2) If a neutral point is not available, devices shall be installed between grounding electrode conductors and impedance grounding conductors connected to the neutral point derived from a grounding transformer.

(B) Insulated.

The impedance grounding conductor shall be insulated for the maximum neutral voltage.

Exception: A bare impedance grounding conductor shall be permitted if the bare portion of the grounding impedance device and conductor are not in a readily accessible location and securely separated from the ungrounded conductors.

Informational Note: The maximum neutral voltage in a 3-phase wye system is 57.7 percent of the phase-to-phase voltage.

(C) System Neutral Point Connections.

System neutral points shall not be connected to ground, except through grounding impedance devices.

Informational Note: See IEEE 3003.1-2019, *Recommended Practice for System Grounding of Industrial and Commercial Power Systems*, for guidance on limiting transient overvoltages.

(D) Impedance Grounding Conductor Routing.

Impedance grounding conductors shall be permitted to be installed in separate raceways from ungrounded conductors. Running impedance grounding conductors with phase conductors to the first system disconnecting means or overcurrent device shall not be required.

(E) Impedance Bonding Jumpers.

(1) Connection.

Impedance bonding jumpers shall be unspliced conductors run from the first system disconnecting means or overcurrent devices to the grounding electrode side of grounding impedance devices.

(2) Size.

Sizing of impedance bonding jumpers shall comply with both the following:

(1) They shall not be less than the larger of 250.187(E)(2)(a) or 250.187(E)(2)(b).

(2) They shall not be smaller than 8 AWG copper or 6 AWG aluminum.

(3) *Connected at Impedance Grounding Devices* . If the grounding electrode conductor connection is made at the impedance grounding device, the impedance bonding jumper shall be sized in accordance with 250.66 , based on the size of the service entrance conductors for a service or the derived phase conductors for a separately derived system.

(4) *Connected at First System Disconnection Means* . If the grounding electrode conductor is connected at the first system disconnecting means or overcurrent device, the impedance bonding jumper shall be sized the same as the impedance grounding conductor.

Informational Note: If the grounding electrode conductor is connected at the impedance grounding device location, the impedance bonding jumper is also the path for lightning impulse currents to the grounding electrode system.

(F) Grounding Electrode Conductor Connection Location.

For services or separately derived systems, grounding electrode conductors shall be connected at any point from the grounded side of grounding impedance devices to the equipment grounding connection at the service equipment or the first system disconnecting means of separately derived systems.

Part III. Grounding Electrode System and Grounding Electrode Conductor

270.50 Grounding Electrode System.

All grounding electrodes as described in 270.52(A)(1) through 270.52(A)(8) that are present at each building or structure served shall be bonded together to form the grounding electrode system. If none of these grounding electrodes exist, one or more of the grounding electrodes specified in 270.52(A)(4) through 270.52(A)(8) shall be installed and used.

Exception: Concrete-encased electrodes of existing buildings or structures shall not be required to be part of the grounding electrode system if the rebar is not accessible for use without disturbing the concrete.

270.52 Grounding Electrodes.

(A) Electrodes Permitted for Grounding.

(1) Metal Underground Water Pipe.

A metal underground water pipe in direct contact with the earth for 3.0 m (10 ft) or more (including any metal well casing bonded to the pipe) and electrically continuous (or made electrically continuous by bonding around insulating joints or insulating pipe) to the points of connection of the grounding electrode conductor and the bonding conductor(s) or jumper(s), if installed.

(2) Metal In-ground Support Structure(s).

One or more metal in-ground support structure(s) in direct contact with the earth vertically for 3.0 m (10 ft) or more, with or without concrete encasement. If multiple metal in-ground support structures are present at a building or a structure, it shall be permissible to bond only one into the grounding electrode system.

Informational Note: Metal in-ground support structures include, but are not limited to, pilings, casings, and other structural metal.

(3) Concrete-Encased Electrode.

A concrete-encased electrode shall consist of at least 6.0 m (20 ft) of either of the following:

(1) One or more bare or zinc galvanized or other electrically conductive coated rebar of not less than 13 mm (½ in.) in diameter, installed in one continuous 6.0 m (20 ft) length, or if in multiple pieces, the rebar shall be connected together by steel tie wires, exothermic welding, welding, or other effective means to create a 6.0 m (20 ft) or greater length

(2) Bare copper conductor not smaller than 4 AWG

Metal components shall be encased by at least 50 mm (2 in.) of concrete and shall be located horizontally within that portion of a concrete foundation or footing that is in direct contact with the earth or within vertical foundations or structural components or members that are in direct contact with the earth. If multiple concrete-encased electrodes are present at a building or structure, it shall be permissible to bond only one into the grounding electrode system.

Informational Note: Concrete installed with insulation, vapor barriers, films, or similar items separating the concrete from the earth is not considered to be in “direct contact” with the earth.

(4) Ground Ring.

A ground ring encircling the building or structure, in direct contact with the earth, consisting of at least 6.0 m (20 ft) of bare copper conductor not smaller than 2 AWG.

(5) Rod and Pipe Electrodes.

Rod and pipe electrodes shall not be less than 2.44 m (8 ft) in length and consist of the following materials:

(1) Grounding electrodes of pipe or conduit shall not be smaller than metric designator 21 (trade size ¾) and, where of steel, shall have the outer surface galvanized or otherwise metal-coated for corrosion protection.

(2) Rod-type grounding electrodes of stainless steel and copper or zinc-coated steel shall be at least 15.87 mm (⅝ in.) in diameter, unless listed.

(6) Other Listed Electrodes.

Other listed grounding electrodes shall be permitted.

(7) Plate Electrodes.

Each plate electrode shall expose not less than 0.186 m^2 (2 ft^2) of surface to exterior soil. Electrodes of bare or electrically conductive coated iron or steel plates shall be at least 6.4 mm (¼ in.) in thickness. Solid, uncoated electrodes of nonferrous metal shall be at least 1.5 mm (0.06 in.) in thickness.

(8) Other Local Metal Underground Systems or Structures.

Other local metal underground systems or structures such as piping systems, underground tanks, and underground metal well casings that are not bonded to a metal water pipe.

(B) Not Permitted for Use as Grounding Electrodes.

The following systems and materials shall not be used as grounding electrodes:

(1) Metal underground gas piping systems

(2) Aluminum

(3) The structures and structural rebar described in 680.26(B)(1) and 680.26(B)(2)

Informational Note: See 270.104(B) for bonding requirements of gas piping.

270.53 Grounding Electrode System Installation.

(A) Rod, Pipe, and Plate Electrodes.

Rod, pipe, and plate electrodes shall be free from nonconductive coatings such as paint or enamel. Rod, pipe, and plate electrodes shall meet the requirements of 270.53(A)(1) through 270.53(A)(3).

(1) Below Permanent Moisture Level.

If practicable, rod, pipe, and plate electrodes shall be embedded below permanent moisture level.

(2) Supplemental Electrode Required.

A single rod, pipe, or plate electrode shall be supplemented by an additional electrode of a type specified in 270.52(A)(2) through 270.52(A)(8). The supplemental electrode shall be permitted to be bonded to one of the following:

(1) Rod, pipe, or plate electrode

(2) Grounding electrode conductor

(3) Grounded service-entrance conductor

(4) Nonflexible grounded service raceway

(5) Any grounded service enclosure

Exception: If a single rod, pipe, or plate grounding electrode has a resistance to earth of 25 ohms or less, the supplemental electrode shall not be required.

(3) Supplemental Electrode.

If multiple rod, pipe, or plate electrodes are installed to meet the requirements of this section, they shall not be less than 1.8 m (6 ft) apart.

Informational Note: The paralleling efficiency of rods is increased by spacing them twice the length of the longest rod.

(4) Rod and Pipe Electrodes.

The electrode shall be installed such that at least 2.44 m (8 ft) of length is in contact with the soil. It shall be driven to a depth of not less than 2.44 m (8 ft) except that, where rock bottom is encountered, the electrode shall be driven at an oblique angle not to exceed 45 degrees from the vertical or, where rock bottom is encountered at an angle up to 45 degrees, the electrode shall be permitted to be buried in a trench that is at least 750 mm (30 in.) deep. The upper end of the electrode shall be flush with or below ground level unless the aboveground end and the grounding electrode conductor attachment are protected against physical damage as specified in 252.10.

(5) Plate Electrode.

Plate electrodes shall be installed not less than 750 mm (30 in.) below the surface of the earth.

(B) Electrode Spacing.

If more than one of the electrodes of the type specified in 270.52(A)(5) or 270.52(A)(7) are used, each electrode of one grounding system (including that used for strike termination devices) shall not be less than 1.83 m (6 ft) from any other electrode of another grounding system.

(C) Bonding Jumper.

The bonding jumper(s) used to connect the grounding electrodes together to form the grounding electrode system shall be installed in accordance with 270.64(A), 270.64(B), and 270.64(E), shall be sized in accordance with 270.66, and shall be connected in the manner specified in 270.702. Rebar shall not be used as a conductor to interconnect the electrodes of grounding electrode systems.

(D) Metal Underground Water Pipe.

If used as a grounding electrode, metal underground water pipe shall meet the requirements of 270.53(D)(1) and 270.53(D)(2).

(1) Continuity.

Continuity of the grounding path or the bonding connection to interior piping shall not rely on water meters or filtering devices and similar equipment.

(2) Supplemental Electrode Required.

A metal underground water pipe shall be supplemented by an additional electrode of a type specified in 270.52(A)(2) through 270.52(A)(8) . If the supplemental electrode is of the rod, pipe, or plate type, it shall comply with 270.53(A) . The supplemental electrode shall be bonded to one of the following:

(1) Grounding electrode conductor

(2) Grounded service-entrance conductor

(3) Nonflexible grounded service raceway

(4) Any grounded service enclosure

(5) As provided by 270.32(B)

Exception: The supplemental electrode shall be permitted to be bonded to the interior metal water piping as specified in 270.68(C)(1).

(E) Supplemental Grounding Electrode Bonding Jumper Size.

If the supplemental electrode is a rod, pipe, or plate electrode, that portion of the bonding jumper that is the sole connection to the supplemental grounding electrode shall not be required to be larger than 6 AWG copper wire or 4 AWG aluminum or copper-clad aluminum wire.

(F) Ground Ring.

The ground ring shall be installed not less than 750 mm (30 in.) below the surface of the earth.

270.54 Auxiliary Grounding Electrodes.

One or more grounding electrodes shall be permitted to be connected to the equipment grounding conductors specified in 270.118 and shall not be required to comply with the electrode bonding requirements of 270.50 or 270.53(C) or the resistance requirements of 270.53(A)(2) Exception, but the earth shall not be used as an effective ground-fault current path as specified in 270.4(A)(5) and 270.4(B)(4) .

270.58 Common Grounding Electrode.

If an ac system is connected to a grounding electrode in or at a building or structure, the same electrode shall be used to ground conductor enclosures and equipment in or on that building or structure. If separate services, feeders, or branch circuits supply a building and are required to be connected to a grounding electrode(s), the same grounding electrode(s) shall be used.

270.60 Use of Strike Termination Devices.

Conductors and driven pipes, rods, or plate electrodes used for grounding strike termination devices shall not be used in lieu of the grounding electrodes required by 270.50 for grounding wiring systems and equipment. This requirement shall not prohibit the required bonding together of grounding electrodes of different systems.

Informational Note No. 1: See270.106 for the bonding requirement of the lightning protection system components to the building or structure grounding electrode system.

Informational Note No. 2: Bonding together of all separate grounding electrodes will limit voltage differences between them and between their associated wiring systems.

270.62 Grounding Electrode Conductor Material.

The grounding electrode conductor shall be of copper, aluminum, copper-clad aluminum, or the items as permitted in 270.68(C). The material selected shall be resistant to any corrosive condition existing at the installation or shall be protected against corrosion. Conductors of the wire type shall be solid or stranded, insulated, covered, or bare.

270.64 Grounding Electrode Conductor Installation.

Grounding electrode conductors at the service, at each building or structure where supplied by a feeder(s) or branch circuit(s), or at a separately derived system shall be installed as specified in 270.64(A) through 270.64(G).

(A) Aluminum or Copper-Clad Aluminum Conductors.

Grounding electrode conductors of bare, covered, or insulated aluminum or copper-clad aluminum shall comply with the following:

(1) Bare or covered conductors without an extruded polymeric covering shall not be installed where subject to corrosive conditions or be installed in direct contact with concrete.

(2) Terminations made within outdoor enclosures that are listed and identified for the environment shall be permitted within 450 mm (18 in.) of the bottom of the enclosure.

(3) Aluminum or copper-clad aluminum conductors external to buildings or equipment enclosures shall not be terminated within 450 mm (18 in.) of the earth.

(B) Securing and Protection Against Physical Damage.

If exposed, a grounding electrode conductor or its enclosure shall be securely fastened to the surface on which it is carried. Grounding electrode conductors shall be permitted to be installed on or through framing members.

(1) Not Exposed to Physical Damage.

A 6 AWG or larger copper, copper-clad aluminum, or aluminum grounding electrode conductor not exposed to physical damage shall be permitted to be run along the surface of the building construction without metal covering or protection.

(2) Exposed to Physical Damage.

A 6 AWG or larger copper, copper-clad aluminum, or aluminum grounding electrode conductor exposed to physical damage shall be protected in rigid metal conduit (RMC), intermediate metal conduit (IMC), Schedule 80 rigid polyvinyl chloride conduit (PVC), reinforced thermosetting resin conduit Type XW (RTRC-XW), electrical metallic tubing (EMT), or cable armor.

(3) Smaller Than 6 AWG.

Grounding electrode conductors smaller than 6 AWG shall be protected in RMC, IMC, Schedule 80 PVC, RTRC-XW, EMT, or cable armor.

(4) In Contact with the Earth.

Grounding electrode conductors and grounding electrode bonding jumpers in contact with the earth shall not be required to comply with 300.5 or 305.15 but shall be buried or otherwise protected if subject to physical damage.

(C) Continuous.

Except as provided in 270.30(A)(5), 270.30(A)(6), 270.30(B)(1), and 270.68(C), grounding electrode conductor(s) shall be installed in one continuous length without a splice or joint. If necessary, splices or connections shall be made as permitted in the following:

(1) Splicing of the wire-type grounding electrode conductor shall be permitted only by irreversible compression-type connectors listed as grounding and bonding equipment or by the exothermic welding process.

(2) Sections of busbars shall be permitted to be connected together to form a grounding electrode conductor.

(3) Bolted, riveted, or welded connections of structural metal frames of buildings or structures.

(4) Threaded, welded, brazed, soldered or bolted-flange connections of metal water piping.

(D) Building or Structure with Multiple Disconnecting Means in Separate Enclosures.

If a building or structure is supplied by a service or feeder with two or more disconnecting means in separate enclosures, the grounding electrode connections shall be made in accordance with 270.64(D)(1), 270.64(D)(2), or 270.64(D)(3).

(1) Common Grounding Electrode Conductor and Taps.

A common grounding electrode conductor and grounding electrode conductor taps shall be installed. The common grounding electrode conductor shall be sized in accordance with 270.66, based on the sum of the circular mil area of the largest ungrounded conductor(s) of each set of conductors that supplies the disconnecting means. If the service-entrance conductors connect directly to the overhead service conductors, service drop, underground service conductors, or service lateral, the common grounding electrode conductor shall be sized in accordance with Table 270.66, Note 1.

A grounding electrode conductor tap shall extend to the inside of each disconnecting means enclosure. The grounding electrode conductor taps shall be sized in accordance with 270.66 for the largest service-entrance or feeder conductor serving the individual enclosure. The tap conductors shall be connected to the common grounding electrode conductor by one of the following methods in such a manner that the common grounding electrode conductor remains without a splice or joint:

(1) Exothermic welding.

(2) Connectors listed as grounding and bonding equipment.

(3) Connections to an aluminum or copper busbar not less than 6 mm thick × 50 mm wide (¼ in. thick × 2 in. wide) and of a length to accommodate the number of terminations necessary for the installation. The busbar shall be securely fastened and shall be installed in an accessible location. Connections shall be made by a listed connector or by the exothermic welding process. If aluminum busbars are used, the installation shall comply with 270.64(A).

(2) Individual Grounding Electrode Conductors.

A grounding electrode conductor shall be connected between the grounding electrode system and one or more of the following, as applicable:

(1) Grounded conductor in each service equipment disconnecting means enclosure

(2) Equipment grounding conductor installed with the feeder(s) or branch circuit(s) for other than services

(3) Supply-side bonding jumper

Each grounding electrode conductor shall be sized in accordance with 270.66 based on the service-entrance or feeder conductor(s) supplying the individual disconnecting means.

(3) Common Location.

A grounding electrode conductor shall be connected in a wireway or other accessible enclosure on the supply side of the disconnecting means to one or more of the following, as applicable:

(1) Grounded service conductor(s)

(2) Equipment grounding conductor installed with the feeder

(3) Supply-side bonding jumper

The connection shall be made with exothermic welding or a connector listed as grounding and bonding equipment. The grounding electrode conductor shall be sized in accordance with 270.66 based on the service-entrance or feeder conductor(s) at the common location where the connection is made.

(E) Raceways, Cable Armor, and Enclosures for Grounding Electrode Conductors.

(1) General.

Ferrous metal raceways, enclosures, and cable armor for grounding electrode conductors shall be electrically continuous from the point of attachment to cabinets or equipment to the grounding electrode and shall be securely fastened to the ground clamp or fitting. Ferrous metal raceways, enclosures, and cable armor shall be bonded at each end of the raceway or enclosure to the grounding electrode or grounding electrode conductor to create an electrically parallel path. Nonferrous metal raceways, enclosures, and cable armor shall not be required to be electrically continuous.

(2) Methods.

Bonding shall be in compliance with 270.92(B) and ensured by one of the methods in 270.92(B)(2) through 270.92(B)(4).

(3) Size.

The bonding jumper for a grounding electrode conductor(s), raceway(s), enclosure(s), or cable armor shall be the same size as, or larger than, the largest enclosed grounding electrode conductor.

(4) Wiring Methods.

If a raceway is used as protection for a grounding electrode conductor, the installation shall comply with the requirements of the applicable raceway article.

(F) Installation to Electrode(s).

Grounding electrode conductor(s) and bonding jumpers interconnecting grounding electrodes shall be installed in accordance with one of the following. The grounding electrode conductor shall be sized for the largest grounding electrode conductor required among all the electrodes connected to it.

(1) The grounding electrode conductor shall be permitted to be run to any convenient grounding electrode available in the grounding electrode system where the other electrode(s), if any, is connected by bonding jumpers that are installed in accordance with 270.53(C).

(2) Grounding electrode conductor(s) shall be permitted to be run to one or more grounding electrode(s) individually.

(3) Bonding jumper(s) from grounding electrode(s) shall be permitted to be connected to an aluminum or copper busbar not less than 6 mm thick × 50 mm wide (¼ in. thick × 2 in wide.) and of sufficient length to accommodate the number of terminations necessary for the installation. The busbar shall be securely fastened and shall be installed in an accessible location. Connections shall be made by a listed connector or by the exothermic welding process. The grounding electrode conductor shall be permitted to be run to the busbar. Where aluminum busbars are used, the installation shall comply with 270.64(A).

(G) Enclosures with Ventilation Openings.

Grounding electrode conductors shall not be installed through a ventilation opening of an enclosure.

270.66 Size of Alternating-Current Grounding Electrode Conductor.

The size of the grounding electrode conductor and bonding jumper(s) for connection of grounding electrodes shall not be smaller than given in Table 270.66, except as permitted in 270.66(A) through 270.66(C).

Table 270.66 Grounding Electrode Conductor for Alternating-Current Systems

Size of Largest Ungrounded Conductor or Equivalent Area for Parallel Conductors (AWG/kcmil)		Size of Grounding Electrode Conductor (AWG/kcmil)	
Copper	Aluminum or Copper-Clad Aluminum	Copper	Aluminum or Copper-Clad Aluminum
2 or smaller	1/0 or smaller	8	6
1 or 1/0	2/0 or 3/0	6	4
2/0 or 3/0	4/0 or 350	4	2
Over 3/0 through 350	Over 350 through 500	2	1/0
Over 350 through 600	Over 500 through 900	1/0	3/0
Over 600 through 1100	Over 900 through 1750	2/0	4/0
Over 1100	Over 1750	3/0	350

Notes:

1. If multiple sets of service-entrance conductors connect directly to a service drop, set of overhead service conductors, set of underground service conductors, or service lateral, the equivalent size of the largest service-entrance conductor shall be determined by the largest sum of the areas of the corresponding conductors of each set.

2. If there are no service-entrance conductors, the grounding electrode conductor size shall be determined by the equivalent size of the largest service-entrance conductor required for the load to be served.

3. See installation restrictions in 252.64.

(A) Connections to a Rod, Pipe, or Plate Electrode(s).

If the grounding electrode conductor or bonding jumper connected to a single or multiple rod, pipe, or plate electrode(s), or any combination thereof, as described in 270.52(A)(5) or 270.52(A)(7), does not extend on to other types of electrodes that require a larger size conductor, the grounding electrode conductor shall not be required to be larger than 6 AWG copper wire or 4 AWG aluminum or copper-clad aluminum wire.

(B) Connections to Concrete-Encased Electrodes.

If the grounding electrode conductor or bonding jumper connected to a single or multiple concrete-encased electrode(s), as described in 270.52(A)(3), does not extend on to other types of electrodes that require a larger size of conductor, the grounding electrode conductor shall not be required to be larger than 4 AWG copper wire.

(C) Connections to Ground Rings.

If the grounding electrode conductor or bonding jumper connected to a ground ring, as described in 270.52(A)(4), does not extend on to other types of electrodes that require a larger size of conductor, the grounding electrode conductor shall not be required to be larger than the conductor used for the ground ring.

270.68 Grounding Electrode Conductor and Bonding Jumper Connection to Grounding Electrodes.

The connection of a grounding electrode conductor at the service, at each building or structure where supplied by a feeder(s) or branch circuit(s), or at a separately derived system and associated bonding jumper(s) shall be made as specified 270.68(A) through 270.68(C).

(A) Accessibility.

All mechanical elements used to terminate a grounding electrode conductor or bonding jumper to a grounding electrode shall be accessible.

Exception No. 1: An encased or buried connection to a concrete-encased, driven, or buried grounding electrode shall not be required to be accessible.

Exception No. 2: Exothermic or irreversible compression connections used at terminations, together with the mechanical means used to attach such terminations to fireproofed structural metal whether or not the mechanical means is reversible, shall not be required to be accessible.

(B) Effective Grounding Path.

The connection of a grounding electrode conductor or bonding jumper to a grounding electrode shall be made in a manner that will ensure an effective grounding path. Where necessary to ensure the grounding path for a metal piping system used as a grounding electrode, bonding shall be provided around insulated joints and around any equipment likely to be disconnected for repairs or replacement. Bonding jumpers shall be of sufficient length to permit removal of such equipment while retaining the integrity of the grounding path.

(C) Grounding Electrode Conductor Connections.

Grounding electrode conductors and bonding jumpers shall be permitted to be connected at the following locations and used to extend the connection to an electrode(s):

(1) Interior metal water piping that is electrically continuous with a metal underground water pipe electrode and is located not more than 1.52 m (5 ft) from the point of entrance to the building, as measured along the water piping, shall be permitted to extend the connection to an electrode(s). Interior metal water piping located more than 1.52 m (5 ft) from the point of entrance to the building, as measured along the water piping, shall not be used as a conductor to interconnect electrodes of the grounding electrode system.

Exception: In industrial, commercial, and institutional buildings or structures, if conditions of maintenance and supervision ensure that only qualified persons service the installation, interior metal water piping located more than 1.52 m (5 ft) from the point of entrance to the building, as measured along the water piping, shall be permitted as a bonding conductor to interconnect electrodes that are part of the grounding electrode system, or as a grounding electrode conductor, if the entire length, other than short sections passing perpendicularly through walls, floors, or ceilings, of the interior metal water pipe that is being used for the conductor is exposed.

(2) The metal structural frame of a building shall be permitted to be used as a conductor to interconnect electrodes that are part of the grounding electrode system, or as a grounding electrode conductor. Hold-down bolts securing the structural steel column that are connected to a concrete-encased electrode complying with 270.52(A)(3) and located in the support footing or foundation shall be permitted to connect the metal structural frame of a building or structure to the concrete-encased grounding electrode. The hold-down bolts shall be connected to the concrete-encased electrode by welding, exothermic welding, steel tie wires, or other approved means.

(3) A rebar-type concrete-encased electrode installed in accordance with 270.52(A)(3) with an additional rebar section extended from its location within the concrete foundation or footing to an accessible location that is not subject to corrosion shall be permitted for connection of grounding electrode conductors and bonding jumpers in accordance with the following:

a. The additional rebar section shall be continuous with the grounding electrode rebar or shall be connected to the grounding electrode rebar and connected together by steel tie wires, exothermic welding, welding, or other effective means.

b. The additional rebar section shall be continuous with the grounding electrode rebar or shall be connected to the grounding electrode rebar and connected together by steel tie wires, exothermic welding, welding, or other effective means.

c. The additional rebar section shall be continuous with the grounding electrode rebar or shall be connected to the grounding electrode rebar and connected together by steel tie wires, exothermic welding, welding, or other effective means.

270.70 Methods of Grounding and Bonding Conductor Connection to Electrodes.

(A) General.

The grounding or bonding conductor shall be connected to the grounding electrode by exothermic welding, listed lugs, listed pressure connectors, listed clamps, or other listed means. Connections depending on solder shall not be used. Ground clamps shall be listed for the materials of the grounding electrode and the grounding electrode conductor and, if used on pipe, rod, or other buried electrodes, shall also be listed for direct soil burial or concrete encasement. Not more than one conductor shall be connected to the grounding electrode by a single clamp or fitting unless the clamp or fitting is listed for multiple conductors.

(B) Indoor Communications Systems.

For indoor communications purposes only, a listed sheet metal strap-type ground clamp having a rigid metal base that seats on the electrode and having a strap of such material and dimensions that it is not likely to stretch during or after installation shall be permitted.

Informational Note: Listed ground clamps that are identified for direct burial are also suitable for concrete encasement.

Part IV. Enclosure, Raceway, and Service Cable Connections

270.80 Service Raceways and Enclosures.

Metal enclosures and raceways for service conductors and equipment shall be connected to the grounded conductor if the electrical system is grounded or to the grounding electrode conductor for electrical systems that are not grounded.

Exception: Metal components that are installed in a run of underground nonmetallic raceway(s) and are isolated from possible contact by a minimum cover of 450 mm (18 in.) to all parts of the metal components shall not be required to be connected to the grounded conductor, supply-side bonding jumper, or grounding electrode conductor.

270.84 Underground Service Cable or Raceway.

(A) Underground Service Cable.

The sheath or armor of a continuous underground metal-sheathed or armored service cable system that is connected to the grounded conductor on the supply side shall not be required to be connected to the grounded conductor at the building or structure. The sheath or armor shall be permitted to be insulated from the interior metal raceway or piping.

(B) Underground Service Raceway Containing Cable.

An underground metal service raceway that contains a metal-sheathed or armored cable connected to the grounded conductor shall not be required to be connected to the grounded conductor at the building or structure. The sheath or armor shall be permitted to be insulated from the interior metal raceway or piping.

270.86 Other Conductor Enclosures and Raceways.

Metal enclosures and raceways for other than service conductors shall be connected to the equipment grounding conductor.

Exception No. 1: Metal enclosures and raceways for conductors added to existing installations of open wire, and nonmetallic-sheathed cable shall not be required to be connected to the equipment grounding conductor if these enclosures or wiring methods comply with all the following:

(1) Do not provide an equipment ground

(2) Are in runs of less than 7.5 m (25 ft)

(3) Are free from probable contact with ground, grounded metal, metal lath, or other conductive material

(4) Are guarded against contact by persons

Exception No. 2: Short sections of metal enclosures or raceways used to provide support or protection of cable assemblies from physical damage shall not be required to be connected to the equipment grounding conductor.

Exception No. 3: Metal components shall not be required to be connected to the equipment grounding conductor or supply-side bonding jumper if either of the following conditions exist:

(1) The metal components are installed in a run of nonmetallic raceway(s) and isolated from possible contact by a minimum cover of 450 mm (18 in.) to any part of the metal components.

(2) The metal components are part of an installation of nonmetallic raceway(s) and are isolated from possible contact to any part of the metal components by being encased in not less than 50 mm (2 in.) of concrete.

Part V. Bonding

270.90 General.

Bonding shall be provided if necessary to ensure electrical continuity and the capacity to conduct safely any fault current likely to be imposed.

270.92 Services.

(A) Bonding of Equipment for Services.

The normally non-current-carrying metal parts of equipment indicated in the following shall be bonded together:

(1) All raceways, cable trays, cablebus framework, auxiliary gutters, or service cable armor or sheath that enclose, contain, or support service conductors, except as permitted in 252.80

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

(B) Method of Bonding at the Service.

Bonding jumpers meeting the requirements of this article shall be used around impaired connections, such as reducing washers or oversized, concentric, or eccentric knockouts. Standard locknuts or bushings shall not be the only means for the bonding required by this section but shall be permitted to be installed to make a mechanical connection of the raceway(s).

Electrical continuity at service equipment, service raceways, and service conductor enclosures shall be ensured by one or more of the following methods:

(1) Bonding equipment to the grounded service conductor by an applicable method in 252.8(A)

(2) Connections made up wrenchtight using threaded couplings, threaded entries, or listed threaded hubs on enclosures

(3) Threadless couplings and connectors if made up tight for metal raceways and metal-clad cables

(4) Other listed devices, such as bonding-type locknuts, bushings, or bushings with bonding jumpers

270.94 Bonding for Communications Systems.

Communications system bonding conductor terminations shall be connected in accordance with 270.94(A) or 270.94(B).

(A) The Intersystem Bonding Termination Device.

An intersystem bonding termination (IBT) for connecting intersystem bonding conductors shall be provided external to enclosures at the service equipment or metering equipment enclosure and at the disconnecting means for any buildings or structures that are supplied by a feeder or branch circuit. If an IBT is used, it shall comply with the following:

(1) Be accessible for connection and inspection

(2) Consist of a set of terminals with the capacity for connection of not less than three intersystem bonding conductors

(3) Not interfere with opening the enclosure for a service, building or structure disconnecting means, or metering equipment

(4) Be securely mounted as follows:

(5) At the service equipment, to a metal enclosure for the service equipment, to a metal meter enclosure, or to an exposed nonflexible metal service raceway, or be connected to the metal enclosure for the grounding electrode conductor with a minimum 6 AWG copper conductor.

(6) At the disconnecting means for a building or structure that is supplied by a feeder or branch circuit, be electrically connected to the metal enclosure for the building or structure disconnecting means, or be connected to the metal enclosure for the grounding electrode conductor with a minimum 6 AWG copper conductor.

(7) Be listed as grounding and bonding equipment

Exception: In existing buildings or structures, if any of the intersystem bonding and grounding electrode conductors required by 750.114(B)(2), 800.100, 810.21(F)(2), and 820.100 exist, installation of an IBT shall not be required. An accessible means external to enclosures for connecting intersystem bonding and grounding electrode conductors shall be permitted at the service equipment and at the disconnecting means for any buildings or structures that are supplied by a feeder or branch circuit by at least one of the following means:

(1) Exposed nonflexible metal raceways

(2) An exposed grounding electrode conductor

(3) Approved means for the external connection of a copper or other corrosion-resistant bonding or grounding electrode conductor to the grounded raceway or equipment

Informational Note: See 750.114, 800.100, 810.21, and 820.100 for intersystem bonding and grounding requirements for conductive optical fiber cables, communications circuits, radio and television equipment, CATV circuits, and network-powered broadband communications systems, respectively.

(B) Other Means.

Connections to an aluminum or copper busbar not less than 6 mm thick × 50 mm wide (¼ in. thick × 2 in. wide) and of a length to accommodate at least three terminations for communication systems in addition to other connections. The busbar shall be securely fastened and shall be installed in an accessible location. Connections shall be made by a listed connector. If aluminum busbars are used, the installation shall also comply with 252.64(A). The busbar shall be connected to the grounding electrode system by a conductor that is the larger of the following:

(1) The largest grounding electrode conductor that is connected to the busbar

(2) As required or permitted in 270.94(A)

Exception to (A) and(B): Means for connecting intersystem bonding conductors shall not be required if communications systems are not likely to be used in or on the building or structure.

Informational Note: The use of an IBT can reduce electrical noise on communication systems.`

270.96 Bonding Other Enclosures.

(A) General.

Metal raceways, cable trays, cable armor, cable sheath, enclosures, frames, fittings, and other metal non-current-carrying parts that are to serve as equipment grounding conductors, with or without the use of wire-type supplementary equipment grounding conductors, shall be bonded if necessary to ensure electrical continuity and the capacity to conduct fault current likely to be imposed on them. Any nonconductive paint, enamel, or similar coating shall be removed at threads, contact points, and contact surfaces or shall be connected by means of fittings designed so as to make such removal unnecessary.

270.97 Bonding.

The electrical continuity of metal raceways and cables with metal sheaths that contain any conductor other than service conductors shall be ensured by one or more of the methods specified for services in 270.92(B), except for 270.92(B)(1).

Exception: If oversized, concentric, or eccentric knockouts are not encountered, or if a box or enclosure with concentric or eccentric knockouts is listed to provide a reliable bonding connection, the following methods shall be permitted:

(1) Threadless couplings and connectors for cables with metal sheaths

(2) Two locknuts, on rigid metal conduit or intermediate metal conduit, one inside and one outside of boxes and cabinets

(3) Fittings with shoulders that seat tightly against the box or cabinet, such as electrical metallic tubing connectors, flexible metal conduit connectors, and cable connectors, with one locknut on the inside of boxes and cabinets

(4) Listed fittings

270.98 Bonding Loosely Jointed Metal Raceways.

Expansion, expansion-deflection, or deflection fittings and telescoping sections of metal raceways shall be made electrically continuous by equipment bonding jumpers or other means.

270.100 Bonding in Hazardous (Classified) Locations.

Regardless of the voltage of the electrical system, the electrical continuity of normally non-current-carrying metal parts of electrical equipment, raceways, metal-clad cable, and metal enclosures containing electrical equipment in any hazardous (classified) location, as defined in 500.5, 505.5, and 506.5, shall be ensured by any of the bonding methods specified in 270.92(B)(2) through 270.92(B)(4). One or more of these bonding methods shall be used whether or not equipment grounding conductors of the wire type are installed in the raceway or in a multiconductor cable assembly.

Informational Note: See 501.30, 502.30, 503.30, 505.30, or 506.30 for specific bonding requirements.

270.102 Grounded Conductor, Bonding Conductors, and Jumpers.

(A) Material.

Bonding jumpers shall be of copper, aluminum, copper-clad aluminum, or other corrosion-resistant material. A bonding jumper shall be a wire, bus, or similar suitable conductor.

(B) Attachment.

Bonding jumpers shall be attached in the manner specified in 270.8 for circuits and equipment and in 270.70 for grounding electrodes.

(C) Size — Supply-Side Bonding Jumper.

(1) Size for Supply Conductors in a Single Raceway or Cable.

The supply-side bonding jumper shall not be smaller than specified in Table 270.102(C)(1).

Table 270.102(C)(1) Grounded Conductor, Main Bonding Jumper, System Bonding Jumper, and Supply-Side Bonding Jumper for Alternating-Current Systems

Size of Largest Ungrounded Conductor or Equivalent Area for Parallel Conductors (AWG/kcmil)		Size of Grounded Conductor or Bonding Jumper (AWG/kcmil)	
Copper	Aluminum or Copper-Clad Aluminum	Copper	Aluminum or Copper-Clad Aluminum
2 or smaller	1/0 or smaller	8	6
1 or 1/0	2/0 or 3/0	6	4
2/0 or 3/0	4/0 or 350	4	2
Over 3/0 through 350	Over 350 through 500	2	1/0
Over 350 through 600	Over 500 through 900	1/0	3/0
Over 600 through 1100	Over 900 through 1750	2/0	4/0
Over 1100	Over 1750	See Notes 1 and 2.	

Notes:

1. If the circular mil area of ungrounded supply conductors that are connected in parallel is larger than 1100 kcmil copper or 1750 kcmil aluminum, the grounded conductor or bonding jumper shall have an area not less than 12½ percent of the area of the largest ungrounded supply conductor or equivalent area for parallel supply conductors. The grounded conductor or bonding jumper shall not be required to be larger than the largest ungrounded conductor or set of ungrounded conductors.

2. If the circular mil area of ungrounded supply conductors that are connected in parallel is larger than 1100 kcmil copper or 1750 kcmil aluminum and if the ungrounded supply conductors and the bonding jumper are of different materials (copper, aluminum, or copper-clad aluminum), the minimum size of the grounded conductor or bonding jumper shall be based on the assumed use of ungrounded supply conductors of the same material as the grounded conductor or bonding jumper that has an ampacity equivalent to that of the installed ungrounded supply conductors.

3. If there are no service-entrance conductors, the supply conductor size shall be determined by the equivalent size of the largest service-entrance conductor required for the load to be served.

(2) Size for Parallel Conductor Installations in Two or More Raceways or Cables.

If the ungrounded supply conductors are connected in parallel in two or more raceways or cables, the supply-side bonding jumper shall be sized in accordance with either of the following:

(1) An individual bonding jumper for each raceway or cable shall be selected from Table 270.102(C)(1) based on the size of the largest ungrounded supply conductor in each raceway or cable.

(2) A single bonding jumper installed for bonding two or more raceways or cables shall be sized in accordance with Table 270.102(C)(1) based on the sum of the circular mil areas of the largest ungrounded conductors from each set connected in parallel in each raceway or cable. The size of the grounded conductor(s) in each raceway or cable shall be based on the largest ungrounded conductor in each raceway or cable, or the sum of the circular mil areas of the largest ungrounded conductors from each set connected in parallel in each raceway or cable.

Informational Note No. 1: The term *supply conductors* includes ungrounded conductors that do not have overcurrent protection on their supply side and terminate at service equipment or the first disconnecting means of a separately derived system.

Informational Note No. 2: See Chapter 9, Table 8, for the circular mil area of conductors 18 AWG through 4/0 AWG.

(D) Size — Equipment Bonding Jumper on Load Side of an Overcurrent Device.

The equipment bonding jumper on the load side of an overcurrent device(s) shall be sized in accordance with 270.122.

A single common continuous equipment bonding jumper shall be permitted to connect two or more raceways or cables if the bonding jumper is sized in accordance with 270.122 for the largest overcurrent device supplying circuits therein.

(E) Installation.

Bonding jumpers or conductors and equipment bonding jumpers shall be permitted to be installed inside or outside of a raceway or an enclosure.

(1) Inside a Raceway or an Enclosure.

If installed inside a raceway, equipment bonding jumpers and bonding jumpers or conductors shall comply with the requirements of 270.119 and 270.148.

(2) Outside a Raceway or an Enclosure.

If installed on the outside, the length of the bonding jumper or conductor or equipment bonding jumper shall not exceed 1.8 m (6 ft) and shall be routed with the raceway or enclosure.

Exception: An equipment bonding jumper or supply-side bonding jumper longer than 1.8 m (6 ft) shall be permitted at outside pole locations for the purpose of bonding or grounding isolated sections of metal raceways or elbows installed in exposed risers of metal conduit or other metal raceway, and for bonding grounding electrodes, and shall not be required to be routed with a raceway or enclosure.

(3) Protection.

Bonding jumpers or conductors and equipment bonding jumpers shall be installed in accordance with 270.64(A) and 270.64(B).

270.104 Bonding of Piping Systems and Exposed Structural Metal.

(A) Metal Water Piping.

The metal water piping system shall be bonded as required in 270.104(A)(1), 270.104(A)(2), or 270.104(A)(3).

(1) General.

Metal water piping system(s) installed in or attached to a building or structure shall be bonded to any of the following:

(1) Service equipment enclosure

(2) Grounded conductor at the service

(3) Grounding electrode conductor, if of sufficient size

(4) One or more grounding electrodes used, if the grounding electrode conductor or bonding jumper to the grounding electrode is of sufficient size

The bonding jumper(s) shall be installed in accordance with 270.64(A), 270.64(B), and 270.64(E). The points of attachment of the bonding jumper(s) shall be accessible. The bonding jumper(s) shall be sized in accordance with Table 270.102(C)(1) except that it shall not be required to be larger than 3/0 copper or 350 kcmil aluminum or copper-clad aluminum and except as permitted in 270.104(A)(2) and 270.104(A)(3).

(2) Buildings of Multiple Occupancy.

In buildings of multiple occupancy where the metal water piping system(s) installed in or attached to a building or structure for the individual occupancies is metallically isolated from all other occupancies by use of nonmetallic water piping, the metal water piping system(s) for each occupancy shall be permitted to be bonded to the equipment grounding terminal of the switchgear, switchboard, or panelboard enclosure (other than service equipment) supplying that occupancy. The bonding jumper shall be sized in accordance with 270.102(D).

(3) Buildings or Structures Supplied by a Feeder(s) or Branch Circuit(s).

The metal water piping system(s) installed in or attached to a building or structure shall be bonded to any of the following:

(1) Building or structure disconnecting means enclosure where located at the building or structure

(2) Equipment grounding conductor run with the supply conductors

(3) One or more grounding electrodes used

The bonding jumper(s) shall be sized in accordance with 270.102(D). The bonding jumper shall not be required to be larger than the largest ungrounded feeder or branch-circuit conductor supplying the building or structure.

(B) Other Metal Piping.

If installed in or attached to a building or structure, a metal piping system(s), including gas piping, that is likely to become energized shall be bonded to any of the following:

(1) Equipment grounding conductor for the circuit that is likely to energize the piping system

(2) Service equipment enclosure

(3) Grounded conductor at the service

(4) Grounding electrode conductor, if of sufficient size

(5) One or more grounding electrodes used, if the grounding electrode conductor or bonding jumper to the grounding electrode is of sufficient size

The bonding conductor(s) or jumper(s) shall be sized in accordance with Table 252.122, and equipment grounding conductors shall be sized in accordance with Table 252.122 using the rating of the circuit that is likely to energize the piping system(s). The points of attachment of the bonding jumper(s) shall be accessible.

Informational Note No. 1: Bonding all piping and metal air ducts within the premises will provide additional safety.

Informational Note No. 2: See NFPA 54-2024, *National Fuel Gas Code*, and NFPA 780-2026, *Standard for the Installation of Lightning Protection Systems*, for information on gas piping systems.

(C) Structural Metal.

Exposed structural metal that is interconnected to form a metal building frame, is not intentionally grounded or bonded, and is likely to become energized shall be bonded to any of the following:

(1) Service equipment enclosure

(2) Grounded conductor at the service

(3) Disconnecting means for buildings or structures supplied by a feeder or branch circuit

(4) Grounding electrode conductor, if not smaller than a conductor sized in accordance with Table 270.102(C)(1)

(5) One or more grounding electrodes used, if the grounding electrode conductor or bonding jumper to the grounding electrode is not smaller than a conductor sized in accordance with Table 270.102(C)(1)

The bonding conductor(s) or jumper(s) shall be sized in accordance with Table 270.102(C)(1), except that it shall not be required to be larger than 3/0 AWG copper or 350 kcmil aluminum or copper-clad aluminum, and installed in accordance with 270.64(A), 270.64(B), and 270.64(E). The points of attachment of the bonding jumper(s) shall be accessible unless installed in compliance with 270.68(A) Exception No. 2.

(D) Separately Derived Systems.

Metal water piping systems and structural metal that is interconnected to form a building frame shall be bonded to separately derived systems in accordance with 270.104(D)(1) through 270.104(D)(3).

(1) Metal Water Piping System(s).

The grounded conductor of each separately derived system shall be bonded to the nearest accessible point of the metal water piping system(s) in the area served by each separately derived system. This connection shall be made at the same point on the separately derived system where the grounding electrode conductor is connected. Each bonding jumper shall be sized in accordance with Table 270.102(C)(1) based on the largest ungrounded conductor of the separately derived system except that it shall not be required to be larger than 3/0 AWG copper or 350 kcmil aluminum or copper-clad aluminum.

Exception No. 1: A separate bonding jumper to the metal water piping system shall not be required if the metal water piping system is used as the grounding electrode or grounding electrode conductor for the separately derived system and the connection to the water piping system is in the area served by the separately derived system.

Exception No. 2: A separate bonding jumper to the metal water piping system shall not be required if the metal in-ground support structure is used as a grounding electrode or the metal frame of a building or structure is used as the grounding electrode conductor for a separately derived system and is bonded to the metal water piping system in the area served by the separately derived system.

(2) Structural Metal.

If exposed structural metal that is interconnected to form the building frame exists in the area served by the separately derived system, it shall be bonded to the grounded conductor of each separately derived system. This connection shall be made at the same point on the separately derived system where the grounding electrode conductor is connected. Each bonding jumper shall be sized in accordance with Table 270.102(C)(1) based on the largest ungrounded conductor of the separately derived system except that it shall not be required to be larger than 3/0 AWG copper or 350 kcmil aluminum or copper-clad aluminum.

Exception No. 1: A separate bonding jumper to the building structural metal shall not be required if the metal in-ground support structure is used as a grounding electrode or the metal frame of a building or structure is used as the grounding electrode conductor for the separately derived system.

Exception No. 2: A separate bonding jumper to the building structural metal shall not be required if the water piping system of a building or structure is used as the grounding electrode or grounding electrode conductor for a separately derived system and is bonded to the building structural metal in the area served by the separately derived system.

(3) Common Grounding Electrode Conductor.

If a common grounding electrode conductor is installed for multiple separately derived systems as permitted by 270.30(A)(6), and exposed structural metal that is interconnected to form the building frame or interior metal water piping exists in the area served by the separately derived system, the metal water piping and the structural metal member shall be bonded to the common grounding electrode conductor in the area served by the separately derived system.

Exception: A separate bonding jumper from each derived system to metal water piping and to structural metal members shall not be required if the metal water piping and the structural metal members in the area served by the separately derived system are bonded to the common grounding electrode conductor.

270.106 Lightning Protection Systems.

The lightning protection system ground terminals shall be bonded to the building or structure grounding electrode system.

Informational Note No. 1: See 270.60 for use of strike termination devices.

Informational Note No. 2: See NFPA 780-2026, *Standard for the Installation of Lightning Protection Systems*, which contains detailed information on grounding, bonding, and sideflash distance from lightning protection systems.

Part VI. Equipment Grounding and Equipment Grounding Conductors

270.109 Metal Enclosures.

Metal enclosures shall be permitted to be used to connect bonding jumpers or equipment grounding conductors, or both, together to become a part of an effective ground-fault current path. If installed, metal covers, plaster rings, extension rings, and metal fittings shall be attached to these metal enclosures to ensure an effective ground-fault current path or shall be connected with bonding jumpers or equipment grounding conductors, or both.

Informational Note: See 252.97 for bonding requirements for over 350 volts to ground.

270.110 Equipment Fastened in Place (Fixed) or Connected by Permanent Wiring Methods.

Exposed, normally non-current-carrying metal parts of fixed equipment supplied by or enclosing conductors or components that are likely to become energized shall be connected to an equipment grounding conductor under any of the following conditions:

(1) If within 2.5 m (8 ft) vertically or 1.5 m (5 ft) horizontally of ground or grounded metal objects and subject to contact by persons

(2) If located in a wet or damp location and not isolated

(3) If in electrical contact with metal

(4) If in a hazardous (classified) location

(5) If supplied by a wiring method that provides an equipment grounding conductor, except as permitted by 252.86 Exception No. 2, for short sections of metal enclosures

(6) If equipment operates with any terminal at over 150 volts to ground

Exception No. 1: If exempted by special permission, the metal frame of electrically heated appliances that have the frame permanently and effectively insulated from ground shall not be required to be grounded.

Exception No. 2: Distribution apparatus, such as transformer and capacitor cases, mounted on wooden poles at a height exceeding 2.5 m (8 ft) above ground or grade level shall not be required to be grounded.

Exception No. 3: Listed equipment protected by a system of double insulation, or its equivalent, shall not be required to be connected to the equipment grounding conductor. If such a system is employed, the equipment shall be distinctively marked.

270.112 Specific Equipment Fastened in Place (Fixed) or Connected by Permanent Wiring Methods.

Exposed, normally non-current-carrying metal parts of equipment described in 270.112(A) through 270.112(G), and normally non-current-carrying metal parts of equipment and enclosures described in 270.112(F) and 270.112(G), shall be connected to an equipment grounding conductor, regardless of voltage.

(A) Switchgear and Switchboard Frames and Structures.

Switchgear or switchboard frames and structures supporting switching equipment, except frames of 2-wire dc switchgear or switchboards if effectively insulated from ground.

(B) Motor Frames.

Motor frames, as provided by 430.242.

(C) Enclosures for Motor Controllers.

Enclosures for motor controllers unless attached to ungrounded portable equipment.

(D) Electric Signs.

Electric signs, outline lighting, and associated equipment as provided in 600.7.

(E) Skid-Mounted Equipment.

Permanently mounted electrical equipment and skids shall be connected to the equipment grounding conductor. Wire-type equipment grounding conductors shall be sized as required by 270.122.

(F) Motor-Operated Water Pumps.

Motor-operated water pumps, including the submersible type.

(G) Metal Well Casings.

If a submersible pump is used in a metal well casing, the well casing shall be connected to the pump circuit equipment grounding conductor.

270.114 Grounding of Equipment.

(A) Equipment Grounding.

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

Exception: If isolated from ground and located such that any person in contact with ground cannot contact such metal parts when the equipment is energized, the metal parts shall not be required to be grounded.

Informational Note: See ,252.110 Exception No. 2 for pole-mounted distribution apparatus.

(B) Grounding Electrode Conductor.

If a grounding electrode conductor connects non-current-carrying metal parts to ground, the grounding electrode conductor shall be sized in accordance with Table 270.66, based on the size of the largest ungrounded service, feeder, or branch-circuit conductors supplying the equipment. The grounding electrode conductor shall not be smaller than 6 AWG copper or 4 AWG aluminum or copper-clad aluminum.

(C) Equipment Grounding Conductor.

Equipment grounding conductors shall comply with 270.114(C)(1) through 252.114(C)(3).

(1) General.

Equipment grounding conductors that are not an integral part of a cable assembly shall not be smaller than 6 AWG copper or 4 AWG aluminum or copper-clad aluminum.

(2) Shielded Cables.

The metallic insulation shield encircling the current-carrying conductors shall be permitted to be used as an equipment grounding conductor, if it is rated for clearing time of ground-fault current protective device operation without damaging the metallic shield. The metallic tape insulation shield and drain wire insulation shield shall not be used as an equipment grounding conductor for solidly grounded systems.

(3) Sizing.

Equipment grounding conductors shall be sized in accordance with Table 250.122(A)based on the current rating of the fuse or the overcurrent setting of the protective relay.

Informational Note: The overcurrent rating for a circuit breaker is the combination of the current transformer ratio and the current pickup setting of the protective relay.

270.115 Grounding of Systems Supplying Portable or Mobile Equipment.

Systems supplying portable or mobile equipment, other than substations installed on a temporary basis, shall comply with 270.115(A) through 270.115(F).

(A) Portable or Mobile Equipment.

Portable or mobile equipment shall be supplied from a system having its neutral conductor grounded through an impedance. If a delta-connected system is used to supply portable or mobile equipment, a system neutral point and associated neutral conductor shall be derived.

(B) Exposed Non-Current-Carrying Metal Parts.

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

(C) Ground-Fault Current.

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

(D) Ground-Fault Detection and Relaying.

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

(E) Isolation.

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

(F) Trailing Cable and Couplers.

Trailing cable and couplers of systems for interconnection of portable or mobile equipment shall meet the requirements of Article 400, Part III, for cables and 495.65 for couplers.

270.118 Types of Equipment Grounding Conductors.

(A) Permitted.

Each equipment grounding conductor run with or enclosing the circuit conductors shall be one or more or a combination of the following:

(1) A copper, aluminum, or copper-clad aluminum conductor. This conductor shall be solid or stranded; insulated, covered, or bare; and in the form of a wire or a busbar of any shape.

(2) Rigid metal conduit.

(3) Intermediate metal conduit.

(4) Electrical metallic tubing.

(5) Listed flexible metal conduit meeting all the following conditions:

(6) The conduit is terminated in listed fittings.

(7) The circuit conductors contained in the conduit are protected by overcurrent devices rated at 20 amperes or less.

(8) The size of the conduit does not exceed metric designator 35 (trade size 1 1/4).

(9) The combined length of flexible metal conduit, flexible metallic tubing, and liquidtight flexible metal conduit in the same effective ground-fault current path does not exceed 1.8 m (6 ft).

(10) If flexibility is necessary to minimize the transmission of vibration from equipment or to provide flexibility for equipment that requires movement after installation, a wire-type equipment grounding conductor or a bonding jumper in accordance with 270.102(E)(2) shall be installed.

(11) If flexible metal conduit is constructed of stainless steel, a wire-type equipment grounding conductor or bonding jumper in accordance with 270.102(E)(2) shall be installed.

(12) Listed liquidtight flexible metal conduit meeting all the following conditions:

(13) The conduit is terminated in listed fittings.

(14) For metric designators 12 through 16 (trade sizes 3/8 through 1/2), the circuit conductors contained in the conduit are protected by overcurrent devices rated at 20 amperes or less.

(15) For metric designators 21 through 35 (trade sizes 3/4 through 1 1/4), the circuit conductors contained in the conduit are protected by overcurrent devices rated not more than 60 amperes and there is no flexible metal conduit, flexible metallic tubing, or liquidtight flexible metal conduit in metric designators 12 through 16 (trade sizes 3/8 through 1/2) in the effective ground-fault current path.

(16) The combined length of flexible metal conduit, flexible metallic tubing, and liquidtight flexible metal conduit in the same effective ground-fault current path does not exceed 1.8 m (6 ft).

(17) If flexibility is necessary to minimize the transmission of vibration from equipment or to provide flexibility for equipment that requires movement after installation, a wire-type equipment grounding conductor or a bonding jumper in accordance with 270.102(E)(2) shall be installed.

(18) If liquidtight flexible metal conduit contains a stainless steel core, a wire-type equipment grounding conductor or a bonding jumper in accordance with 270.102(E)(2) shall be installed.

(19) Flexible metallic tubing if the tubing is terminated in listed fittings and meeting the following conditions:

(20) The circuit conductors contained in the tubing are protected by overcurrent devices rated at 20 amperes or less.

(21) The combined length of flexible metal conduit, flexible metallic tubing, and liquidtight flexible metal conduit in the same effective ground-fault current path does not exceed 1.8 m (6 ft).

(22) Armor of Type AC cable as provided in 320.108.

(23) The copper sheath of mineral-insulated, metal-sheathed cable Type MI.

(24) Type MC cable that provides an effective ground-fault current path in accordance with one or more of the following:

(25) It contains an insulated or uninsulated equipment grounding conductor in compliance with 252.118(1).

(26) The combined metallic sheath and uninsulated equipment grounding/bonding conductor of interlocked metal-tape-type MC cable that is listed and identified as an equipment grounding conductor.

(27) The metallic sheath or the combined metallic sheath and equipment grounding conductors of the smooth- or corrugated-tube-type MC cable that is listed and identified as an equipment grounding conductor.

(28) Cable trays as permitted in 392.10 and 392.60.

(29) Cablebus framework as permitted in 370.60(1).

(30) Other listed electrically continuous metal raceways and listed auxiliary gutters.

(31) Surface metal raceways listed for grounding.

Informational Note: See Article 100 for a definition of *effective ground-fault current path*.

(B) Not Permitted.

The following shall not be used as equipment grounding conductors:

(1) Grounding electrode conductors

Exception to (1): A wire-type equipment grounding conductor installed in compliance with 270.6(A) and the applicable requirements for both the equipment grounding conductor and the grounding electrode conductor in Article 270, Parts II, III, and VI, shall be permitted to serve as both an equipment grounding conductor and a grounding electrode conductor.

(2) Structural metal frame of a building or structure

270.119 Identification of Wire-Type Equipment Grounding Conductors.

(A) General.

Unless required elsewhere in this code, equipment grounding conductors shall be permitted to be bare, covered, or insulated. Individually covered or insulated equipment grounding conductors of the wire type shall have a continuous outer finish that is either green or green with one or more yellow stripes except as permitted in this section. Conductors with insulation or individual covering that is green, green with one or more yellow stripes, or otherwise identified as permitted by this section shall not be used for ungrounded or grounded circuit conductors.

(B) Conductors 4 AWG and Larger.

Equipment grounding conductors 4 AWG and larger shall comply with the following:

(1) At the time of installation, if the insulation does not comply with 270.119(A), it shall be permanently identified as an equipment grounding conductor at each end and at every point where the conductor is accessible.

Exception to (1): Conductors 4 AWG and larger shall not be required to be marked in conduit bodies that contain no splices or unused hubs.

(2) Identification shall encircle the conductor and shall be accomplished by one of the following:

(3) Stripping the insulation or covering from the entire exposed length

(4) Coloring the insulation or covering green at the termination

(5) Marking the insulation or covering with green tape or green adhesive labels at the termination

(C) Multiconductor Cable.

One or more insulated conductors in a multiconductor cable, at the time of installation, shall be permitted to be permanently identified as equipment grounding conductors at each end and at every point where the conductors are accessible by one of the following means:

(1) Stripping the insulation from the entire exposed length.

(2) Coloring the exposed insulation green.

(3) Marking the exposed insulation with green tape or green adhesive labels. Identification shall encircle the conductor.

(D) Flexible Cord.

Equipment grounding conductors in flexible cords shall be insulated and shall have a continuous outer finish that is either green or green with one or more yellow stripes.

270.120 Equipment Grounding Conductor Installation.

An equipment grounding conductor shall be installed in accordance with 270.120(A), 270.120(B), and 270.120(C).

(A) Raceway, Cable Trays, Cable Armor, Cablebus, or Cable Sheaths.

If it consists of a raceway, cable tray, cable armor, cablebus framework, or cable sheath or if it is a wire within a raceway or cable, it shall be installed in accordance with the applicable provisions in this code using fittings for joints and terminations approved for use with the type of raceway or cable used. All connections, joints, and fittings shall be made tight using suitable tools.

Informational Note: See the UL Guide Information for Electrical Circuit Integrity Systems (FHIT) for equipment grounding conductors installed in a raceway that are part of a listed electrical circuit protective system or a listed fire-resistive cable system.

(B) Aluminum and Copper-Clad Aluminum Conductors.

Equipment grounding conductors of bare, covered, or insulated aluminum or copper-clad aluminum shall comply with the following:

(1) Unless part of an applicable cable wiring method, bare or covered conductors shall not be installed if subject to corrosive conditions or be installed in direct contact with concrete, masonry, or the earth.

(2) Terminations made within outdoor enclosures that are listed and identified for the environment shall be permitted within 450 mm (18 in.) of the bottom of the enclosure.

(3) Aluminum or copper-clad aluminum conductors external to buildings or enclosures shall not be terminated within 450 mm (18 in.) of the earth, unless terminated within a listed wire connector system.

(C) Equipment Grounding Conductors Smaller Than 6 AWG.

If not routed with circuit conductors as permitted in 250.130(C) and 270.134 Exception No. 2, equipment grounding conductors smaller than 6 AWG shall be protected from physical damage by an identified raceway or cable armor unless installed within hollow spaces of the framing members of buildings or structures and if not subject to physical damage.

270.122 Size of Equipment Grounding Conductors.

(A) General.

Unless permitted elsewhere in the code, the equipment grounding conductor shall be one, or more, of the combination of the type provided in 270.118. Equipment grounding conductors shall comply with 270.4(A)(5) and 270.4(B)(4).

Table 270.122(A) Smallest Acceptable Grounding Conductor in Multiple Conductor Cables, or with Two or More Insulated Conductors Such As Duplexed, Triplexed, and Quadruplexed Type, 1001 Volts to 2000 Volts

Copper (AWG or kcmil)		Aluminum AWG or kcmil)	
Size of Circuit Conductor	Smallest Size of Unsectioned Grounding Conductor	Size of Circuit Conductor	Smallest Size of Unsectioned Grounding Conductor
14	14	12	12
12	12	10	10
10–8	10	8–6	8
8	10	4–1	6
6–3	8	1/0–4/0	4
2–3/0	6	250–400	2
4/0–300	4	500–800	1
350–500	3	900–1000	1/0

Note: Based on UL 1277, Table 8.1 and Table 8.2, and UL 1569, Table 6.2.

(B) Wire Type Equipment Grounding Conductor.

Equipment grounding conductors of the wire type shall be sized according to 270.122(B)(1), 270.122(B)(2), or 270.122(B)(3) below but shall not be required to be larger than the circuit conductors.

(1) Equipment grounding conductor for multiple conductor cable for 1001 V to 2000 V application shall not be smaller than as shown in Table 270.122(B). Equipment grounding conductors shall be permitted to be sectioned within a multiconductor cable if the combined circular mil area complies with Table 270.122(B)

(2) Equipment grounding conductor for Type MV-90 multiple conductor cable for 2001 V to 35,000 V application shall not be smaller than as shown in Table 270.122(B). Equipment grounding conductors shall be permitted to be sectioned within a multiconductor cable if the combined circular mil area complies with Table 270.122(B)

(3) Equipment grounding conductor for Type MV-105 multiple conductor cable for 2001 V to 35,000 V application shall not be smaller than as shown in Table 252.122(B)(3). Equipment grounding conductors shall be permitted to be sectioned within a multiconductor cable if the combined circular mil area complies with Table 270.122(B)

Exception to (1), (2), and (3): Equipment grounding conductors shall be permitted to be sized by a qualified person to provide an effective ground fault current path in accordance with 270.4(A)(5) or 270.4(B)(4).

Table 270.122(B) Smallest Acceptable Grounding Conductor in Multiconductor Cables, or With Two or More Type MV-90 Insulated Conductors, 2,001 Volts to 35,000 Volts

Copper		Aluminum	
Size of Circuit Conductors (AWG or kcmil)	Smallest Size of Sectioned Grounding Conductor (AWG)	Size of Circuit Conductor (AWG or kcmil)	Smallest Size of Sectioned Grounding Conductor (AWG)
8	8	8–6	6
6–2	6	4–1/0	4
1–2/0	4	2/0–250	2
3/0–250	3	300–400	1
300–400	2	450–600	1/0
450–600	1	750–900	2/0
750–1000	1/0	1000	3/0

Note: Based on UL 1072, Table 23.1.

(C) Metallic Insulation Shield or Armor of the Cables.

The metallic insulation shield, metallic armor, or a combination of both encircling the current-carrying conductors shall be permitted to be used as an equipment grounding conductor, if it is rated for clearing time of ground-fault current protective device operation without damaging the metallic shield. The tape metallic insulation shield and drain wire insulation shield shall not be used as an equipment grounding conductor for solidly grounded systems.

Table 270.122(C) Smallest Acceptable Grounding Conductor in Multiconductor Cables, or With Two or More Type MV-105 Insulated Conductors, 2,001 Volts to 35,000 Volts

Copper		Aluminum	
Size of Circuit Conductors (AWG or kcmil)	Smallest Size of Sectioned Grounding Conductor (AWG)	Size of Circuit Conductor (AWG or kcmil)	Smallest Size of Sectioned Grounding Conductor (AWG)
8	8	8–6	6
6–2	6	4–1/0	4
1–2/0	4	2/0–4/0	2
3/0–4/0	3	250–350	1
250–350	2	400–500	1/0
400–500	1	550–750	2/0
550–750	1/0	800–1000	3/0
800–1000	2/0	-	-

Note: Based on UL 1072, Table 23.2.

(D) Multiple Circuits.

A single equipment grounding conductor shall be permitted to be installed for multiple circuits that are installed in the same raceway, cable, trench, or cable tray. It shall be sized according to 270.122(B) for the largest circuit conductors in the raceway, cable, trench, or cable tray. Equipment grounding conductors installed in cable trays shall meet the minimum requirements of 392.10(B)(1)(c).

(E) Conductors in Parallel.

For circuits of parallel conductors as permitted in 310.10(G), the equipment grounding conductor shall be installed in accordance with 270.122(E)(1) or 270.122(E)(2).

(1) Conductor Installations in Raceways, Auxiliary Gutters, or Cable Trays.

(a) *Single Raceway or Cable Tray, Auxiliary Gutter, or Cable Tray*. If circuit conductors are connected in parallel in the same raceway, auxiliary gutter, or cable tray, a single wire-type conductor shall be permitted as the equipment grounding conductor. The wire-type equipment grounding conductor shall be sized in accordance with 270.122(B) based on the largest circuit conductor within the raceway or cable.

(b) *Multiple Raceways*. If conductors are installed in multiple raceways and are connected in parallel, a wire-type equipment grounding conductor, if used, shall be installed in each raceway and shall be connected in parallel. The equipment grounding conductor installed in each raceway shall be sized in accordance with 270.122(B) based on the largest circuit conductor in each raceway or cable.

(c) *Wire-Type Equipment Grounding Conductors in Cable Trays*. Wire-type equipment grounding conductors installed in cable trays shall meet the minimum requirements of 392.10(B)(1)(c).

(2) Multiconductor Cables.

(a) Except as provided in 270.122(E)(2)(c) for raceway or cable tray installations, the equipment grounding conductor in each multiconductor cable shall be sized in accordance with 270.122(B) based on the largest circuit conductor in the cable.

(b) If circuit conductors of multiconductor cables are connected in parallel, the equipment grounding conductor(s) in each cable shall be connected in parallel.

(c) If multiconductor cables are paralleled in the same raceway, auxiliary gutter, or cable tray, a single equipment grounding conductor that is sized in accordance with 270.122(B) shall be permitted in combination with the equipment grounding conductors provided within the multiconductor cables and shall all be connected together.

(F) Feeder Taps.

Equipment grounding conductors installed with feeder taps shall not be smaller than shown in 270.122(B) based on the largest circuit conductor of the feeder on the supply side ahead of the tap but shall not be required to be larger than the tap conductors.

270.124 Equipment Grounding Conductor Continuity.

(A) Separable Connections.

Separable connections such as those provided in drawout equipment or attachment plugs and mating connectors and receptacles shall provide for first-make, last-break of the equipment grounding conductor. First-make, last-break shall not be required if interlocked equipment, plugs, receptacles, and connectors preclude energization without grounding continuity.

(B) Switches.

No automatic cutout or switch shall be placed in the equipment grounding conductor of a premises wiring system unless the opening of the cutout or switch disconnects all sources of energy.

Part VII. Methods of Equipment Grounding Conductor Connections

270.130 Equipment Grounding Conductor Connections.

Equipment grounding conductor connections at the source of separately derived systems shall be made in accordance with 270.30(A)(1). Equipment grounding conductor connections at service equipment shall be made as indicated in 270.130(A) or 270.130(B).

(A) For Grounded Systems.

The connection shall be made by bonding the equipment grounding conductor to the grounded service conductor and the grounding electrode conductor.

(B) For Ungrounded Systems.

The connection shall be made by bonding the equipment grounding conductor to the grounding electrode conductor.

270.132 Short Sections of Raceway or Cable Armor.

Isolated sections of metal raceway or cable armor, if required to be connected to an equipment grounding conductor, shall be connected in accordance with 270.134.

270.134 Equipment Fastened in Place or Connected by Permanent Wiring Methods (Fixed).

Unless connected to the grounded circuit conductor as permitted by 270.32, 270.140, and 270.142, non-current-carrying metal parts of equipment, raceways, and other enclosures, if grounded, shall be connected to an equipment grounding conductor by one of the following methods:

(1) By connecting to any of the equipment grounding conductors permitted by 252.118(2) through 252.118(14)

(2) By connecting to an equipment grounding conductor of the wire type that is contained within the same raceway, contained within the same cable, or otherwise run with the circuit conductors

Exception: For dc circuits, the equipment grounding conductor shall be permitted to be run separately from the circuit conductors.

Informational Note No. 1: See 270.102 and 270.168 for equipment bonding jumper requirements.

Informational Note No. 2: See 400.10 for use of flexible cords and flexible cables for fixed equipment.

270.136 Equipment Secured to a Metal Rack or Structure.

If a metal rack or structure is connected to an equipment grounding conductor in accordance with 270.134, it shall be permitted to serve as the equipment grounding conductor for electrical equipment secured to and in electrical contact with the metal rack or structure.

270.138 Cord-and-Plug-Connected Equipment.

Non-current-carrying metal parts of cord-and-plug-connected equipment, if required to be connected to an equipment grounding conductor, shall be connected by one of the methods in 270.138(A) or 270.138(B).

(A) By Means of an Equipment Grounding Conductor.

By means of an equipment grounding conductor run with the power supply conductors in a cable assembly or flexible cord properly terminated in a grounding-type attachment plug with one fixed grounding contact.

(B) By Means of a Separate Flexible Wire or Strap.

By means of a separate flexible wire or strap, insulated or bare, connected to an equipment grounding conductor, and protected as well as practicable against physical damage, if part of equipment.

270.140 Frames of Ranges and Clothes Dryers.

Frames of electric ranges, wall-mounted ovens, counter-mounted cooking units, clothes dryers, and outlet or junction boxes that are part of the circuit shall be connected to the equipment grounding conductor in accordance with 270.140(A).

(A) Equipment Grounding Conductor Connections.

The circuit supplying the equipment shall include an equipment grounding conductor. The frame of the equipment shall be connected to the equipment grounding conductor in the manner specified by 270.134 or 270.138.

270.142 Use of Grounded Circuit Conductor for Grounding Equipment.

(A) Supply-Side Equipment.

A grounded circuit conductor shall be permitted to be connected to non-current-carrying metal parts of equipment, raceways, and other enclosures at any of the following locations:

(1) On the supply side or within the enclosure of the ac service disconnecting means

(2) On the supply side or within the enclosure of the main disconnecting means for separate buildings as provided in 270.32(B)(1) Exception No. 1

(3) On the supply side or within the enclosure of the main disconnecting means or overcurrent devices of a separately derived system where permitted by 270.30(A)(1)

(B) Load-Side Equipment.

Except as permitted in 270.30(A)(1), 270.32(B)(1) Exception No. 1, a grounded circuit conductor shall not be connected to non-current-carrying metal parts of equipment on the load side of the service disconnecting means or on the load side of a separately derived system disconnecting means or the overcurrent devices for a separately derived system not having a main disconnecting means.

Exception No. 1: It shall be permissible to connect meter enclosures to the grounded circuit conductor on the load side of the service disconnect if all of the following conditions apply:

(1) Ground-fault protection of equipment is not installed.

(2) All meter enclosures are located immediately adjacent to the service disconnecting means.

(3) The size of the grounded circuit conductor is not smaller than the size specified in Table 252.122 for equipment grounding conductors.

Exception No. 2: Electrode-type boilers operating at over 1000 volts shall be grounded as required in 495.72(E)(1) and 495.74.

270.144 Multiple Circuit Connections.

If equipment is required to be grounded and is supplied by more than one circuit containing an equipment grounding conductor, a means to terminate each equipment grounding conductor meeting the requirements of 270.8 shall be provided as specified in 270.134 and 270.138.

270.148 Continuity of Equipment Grounding Conductors and Attachment in Boxes.

If circuit conductors are spliced within a box or terminated on equipment within or supported by a box, the installation shall comply with 270.148(A) through 252.148(D).

Exception: The equipment grounding conductor permitted in 252.146(D) shall not be required to be connected to the other equipment grounding conductors or to the box.

(A) Connections and Splices.

All equipment grounding conductors that are spliced or terminated within the box shall be connected together. Connections and splices shall be made in accordance with 110.14(B) and 270.8 except that insulation shall not be required.

(B) Metal Boxes.

A connection used for no other purpose shall be made between the metal box and the equipment grounding conductor(s). The equipment bonding jumper or equipment grounding conductor shall be sized from Table 252.122 based on the largest overcurrent device protecting circuit conductors in the box.

(C) Nonmetallic Boxes.

One or more equipment grounding conductors brought into a nonmetallic box shall be arranged to provide a connection to any fitting or device in that box requiring connection to an equipment grounding conductor.

Part VIII. Direct-Current Systems

270.160 General.

Direct-current systems shall comply with Article 270, Part VIII, and other sections not specifically intended for ac systems.

270.162 Direct-Current Circuits and Systems to Be Grounded.

Direct-current circuits and systems shall be grounded as provided for in 270.162(A) and 270.162(B).

(A) Two-Wire, Direct-Current Systems.

A system equipped with a ground detector and supplying only industrial equipment in limited areas shall not be required to be grounded if installed immediately adjacent to, or integral with, the source of supply.

A rectifier-derived dc system supplied from an ac system complying with 270.20 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.

270.164 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.

(B) On-Premises Source.

If the dc system source is located on the premises, a grounding connection shall be made at one of the following:

(1) The source

(2) The first system disconnection means or overcurrent device

(3) By other means that accomplish system protection and that use equipment listed and identified for the use

270.166 Size of the Direct-Current Grounding Electrode Conductor.

The size of the grounding electrode conductor for a dc system shall be as specified in 270.166(A) and 270.166(B), except as permitted by 270.166(C) through 270.166(E). The grounding electrode conductor for a dc system shall meet the sizing requirements in this section but shall not be required to be larger than 3/0 copper or 350 kcmil aluminum or copper-clad aluminum.

(A) Not Smaller Than the Neutral Conductor.

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

(B) Not Smaller Than the Largest Conductor.

If the dc system is other than as in 270.166(A), the grounding electrode conductor shall not be smaller than the largest conductor supplied by the system and not smaller than 8 AWG copper or 6 AWG aluminum or copper-clad aluminum.

(C) Connected to Rod, Pipe, or Plate Electrodes.

If connected to rod, pipe, or plate electrodes as in 270.52(A)(5) or 270.52(A)(7), that portion of the grounding electrode conductor that is the sole connection to the grounding electrode shall not be required to be larger than 6 AWG copper wire or 4 AWG aluminum or copper-clad aluminum wire.

(D) Connected to a Concrete-Encased Electrode.

If connected to a concrete-encased electrode as in 270.52(A)(3), that portion of the grounding electrode conductor that is the sole connection to the grounding electrode shall not be required to be larger than 4 AWG copper wire.

(E) Connected to a Ground Ring.

If connected to a ground ring as in 270.52(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.

270.167 Direct-Current Ground-Fault Detection.

(A) Ungrounded Systems.

Ground-fault detection systems shall be required for ungrounded systems.

(B) Grounded Systems.

Ground-fault detection shall be permitted for grounded systems.

(C) Marking.

Direct-current systems shall be legibly marked to indicate the grounding type at the dc source or the first disconnecting means of the system. The marking shall be of sufficient durability to withstand the environment involved.

> Informational Note: See NFPA 70E-2024, *Standard for Electrical Safety in the Workplace*, which identifies four dc grounding types in detail.

270.168 Direct-Current System Bonding Jumper.

For direct-current systems that are to be grounded, an unspliced bonding jumper shall be used to connect the equipment grounding conductor(s) to the grounded conductor at the source or to the first system disconnecting means where the system is grounded. The size of the bonding jumper shall not be smaller than the system grounding electrode conductor specified in 270.166 and shall comply with 270.28(A), 270.28(B), and 270.28(C).

270.169 Ungrounded Direct-Current Separately Derived Systems.

Except as otherwise permitted in 270.34 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 Article 270, 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 270.166.

Part IX. Instruments, Meters, and Relays

270.170 Instrument Transformer Circuits.

Secondary circuits of current and potential instrument transformers shall be grounded.

Exception: Current transformer secondaries connected in a three-phase delta configuration shall not be required to be grounded.

270.172 Instrument Transformer Cases.

Cases or frames of instrument transformers shall be connected to the equipment grounding conductor if accessible to other than qualified persons.

270.176 Cases of Instruments, Meters, and Relays — Operating at Over 1000 Volts.

If instruments, meters, and relays have current-carrying parts of over 1000 volts to ground, they shall be isolated by elevation or protected by a barrier(s), grounded metal, or insulating covers or guards. Their cases shall not be connected to the equipment grounding conductor.

Exception: Cases of electrostatic ground detectors shall be permitted to be connected to an equipment grounding conductor if the internal ground segments of the instrument are connected to the instrument case and grounded and the ground detector is isolated by elevation.

270.178 Instrument Equipment Grounding Conductor.

The equipment grounding conductor for secondary circuits of instrument transformers and for instrument cases shall not be smaller than 12 AWG copper or 10 AWG aluminum or copper-clad aluminum. Cases of instrument transformers, instruments, meters, and relays that are mounted directly on grounded metal surfaces of enclosures or grounded metal of switchgear or switchboard panels shall not be required to be connected to an additional equipment grounding conductor.

Supplemental Information

File Name	Description	Approved
270.docx	For prod use	
Figure_270.1.jpg	staff use - draft revised figure 250.1 informational note no. 1. For editorial use only	

Submitter Information Verification

Committee: NEC-P05

Submittal Date: Wed Oct 23 13:06:16 EDT 2024

Committee Statement

Committee Statement: 270.1 - Inserted new informational note - This informational note was originally in 250.191 and was brought over to 270.13 in the First Draft. Section 270.13 is being eliminated, so the informational note is being moved to this section.

270.1 - Modified figure - Part X has been removed from Article 270 as the whole article is over 1000 volts.

270.5 - Inserted new section - It is recognized that some supervised installations may have grounding and bonding designs by qualified persons under engineering supervision that are not contained in this article. This wording is similar to the wording in 265.19(B), 266.4(C), 267.39(C), 268.23 (C), 268.31, 268.42.

270.13 - Deleted the section - The requirements of section 270.13 are redundant with 270.20 and 270.21. The informational note was relocated to 270.1, as indicated above.

270.14 - Revised title - The title of 270.14 was revised to clarify that this section only applies to fences and metal structures that are associated with substations.

270.14 - Revised text - The phrase “as required by 270.14(A) or 270.14(B)” was added to the charging text of 270.14 to clarify how the subsections are to be applied. The text was not added in 270.4, as proposed by PC-1781, because grounding and bonding of fences does not belong in the General Requirements section.

270.20 - Revised text - The revised text provides a roadmap for users to find applicable requirements for different configurations.

270.21(A) - Added list item (3) - Delta connected systems are added to the list as they are a type of over 1000 volt system that is not required to be grounded.

270.21(B) - Revised list item (1) - The cross-reference to the list in 270.21(A) was updated to include new list item (3).

270.24(A)(1) - Revised text - The revised text eliminates confusion over the term "grounding electrode conductor."

270.24(B)(1) - Revised text - The revised text eliminates confusion over the term

"grounding electrode conductor."

270.24(C) and (D) - Inserted new subsections - When 250.24 was replaced 250.186, it then became 270.24. The new 270.24 did not cover the requirements for a GEC and ungrounded system grounding connections as found in 250.24, so these requirements are added back in.

270.25(A) - Revised cross-reference - The reference was updated to fit new structure of the section.

270.25(B) - Revised cross-reference - The reference was updated to fit new structure of the section.

270.27(B) - Deleted list item (8) - Item (8) is already covered elsewhere, such as 270.4, 270.118, and 270.119.

270.28(A) and (B) - Deleted text - A screw is not a listed bonding jumper at medium voltage. The last sentence of (A) is deleted because it does not add value if the word "screw" was deleted. Subsection (B) was deleted because it only referred to using screws as a bonding jumper.

270.28(C)(2) - Revised cross-reference - The reference was corrected to correlate with new Article 268.

270.30(A)(8) - Revised cross-reference - The cross-reference was not updated when the Correlating Committee renumbered new Article 252 to Article 270.

270.30(B)(2) - Revised cross-reference - The cross-reference was not updated when the Correlating Committee renumbered new Article 252 to Article 270.

270.32(A) - Deleted exception - Systems over 1000 V have a higher risk of induced voltages, voltage gradients, and shock hazards so establishing a grounding electrode system in a building or structure fed by an over 1000 V AC system is important to mitigate risk.

270.32(D) - Revised cross-reference - The reference was corrected to correlate with new Article 267.

270.32(D)(2) - Revised text - This correlates with the change in 270.32(A).

270.32(D)(3) - Revised text - Panelboards are not rated for over 1000 VAC or 1500 VDC.

270.32(E) - Revised cross-reference - The cross-reference was not updated when the Correlating Committee renumbered new Article 252 to Article 270.

270.36(E)(2)(1) - Revised cross-references - The section numbers were changed to correspond to the new article number.

270.36(E)(2)(2) - Revised text - Copper clad aluminum is added to be consistent with 250.36(B).

270.36(E)(2)(2)(a) - Revised cross-reference - The section number was changed to correspond to the new article number.

270.52(A)(3) - Revised informational note - The informational note was revised to provide examples to assist users in understanding the concept of direct contact with the earth.

270.53(A)(4) - Revised cross-reference - The cross-reference was not updated when the Correlating Committee renumbered new Article 252 to Article 270.

270.66 - Revised cross-reference - The cross-reference in Table Note 3 was not updated when the Correlating Committee renumbered new Article 252 to Article 270.

270.92(A)(1) - Revised cross-reference - The cross-reference was not updated when the Correlating Committee renumbered new Article 252 to Article 270.

270.92(B)(1) - Revised cross-reference - The cross-reference was not updated when the Correlating Committee renumbered new Article 252 to Article 270.

270.94(B) - Revised cross-reference - The cross-reference was not updated when the Correlating Committee renumbered new Article 252 to Article 270.

270.96 - Deleted Subsection (A) and moved the text to the main section - Subsection (A) was not needed as there is no Subsection (B). Section 250.96 includes a subsection (B) for “Isolated Grounding Circuits,” but it is applicable only to circuits below 1000 Vac, 1500 Vdc.

270.97 - Revised title - The revised title better describes the contents of the section.

270.104(B) - Revised cross-reference - The cross-reference was not updated when the Correlating Committee renumbered new Article 252 to Article 270.

270.109 - Revised text - Plaster rings and extension Rings are not applicable to systems over 1000 Vac or 1500 Vdc. The Informational Note was deleted because it is not applicable to systems over 1000 Vac or 1500 Vdc.

270.110 - Revised cross-reference - The cross-reference in list item (5) was not updated when the Correlating Committee renumbered new Article 252 to Article 270.

270.110 - Deleted list item (6) - All equipment covered by the new Article 270 operates at over 150 volts to ground so list item (6) is not necessary.

270.112 - Revised cross-reference - The cross-references for exposed, non-current-carrying metal parts of equipment were changed from subsections (A) through (G) to subsections (A) through (E) to correspond with the listed items.

270.112(A) Revised title and text - Switchboards are not listed for over 1000V ac or 1500V dc, so the term "switchboard" is not applicable to Article 270.

270.114(A) - Revised cross-reference - The cross-reference was not updated when the Correlating Committee renumbered new Article 252 to Article 270.

270.114(C) - Deleted subsection - These requirements were deleted because they are already covered in 270.122.

270.118(A) - Revised text - The charging statement in 270.118(A) was updated to match 250.118(A). Both sections have similar intended requirements, even though they apply to different voltage levels.

270.118(A) - Deleted list items (5) through (7) - These wiring methods, while permitted for medium voltage, are not adequate for use as an equipment grounding conductor, as the current damage curve for medium voltage overcurrent devices are not addressed in the product standard for LFMC.

270.118(A) - Deleted list item (8) - Type AC cable is not listed in Table 305.12 as being permitted in over 1000 V wiring methods.

270.118(A) - Deleted list item (9) - Type MI cable is not listed in Table 305.12 as being permitted in over 1000 V wiring methods.

270.118(A) - Revised ist item (10) - The cross-reference was not updated when the Correlating Committee renumbered new Article 252 to Article 270.

270.118(A) - Deleted list item (14) - Surface metal raceways were deleted because they are not suitable for over 1000 Vac or 1500 Vdc.

270.118(B) - Added new list item (3) - A new list item was added to reinforce that tape metallic insulation shield and drain wire insulation shield shall not be used as an equipment grounding conductor for solidly grounded systems, as established in 270.122(C).

270.120(A) - Deleted informational note - The Informational Note was not applicable to over 1000 V requirements.

270.120(C) - Deleted cross-reference - Section 250.130(C) is not applicable to over 1000 V installations.

270.122(A) - Moved table - Table 270.122(A) was moved to 270.122(B) and relabeled in accordance with the NEC Style Manual. "Grounding Conductor" is no longer a defined term in the NEC, so all instances in the table were changed to "Equipment Grounding Conductor," which is defined in Article 100.

270.122(B) - Revised text - These requirements were originally in 250.190(C) and were relocated to 270.114. The minimum size of the EGC should be located in 270.122, which addresses sizing of the EGC. The section was revised to comply with the NEC Style Manual. "Grounding Conductor" is no longer a defined term in the NEC, so all instances in the table were changed to "Equipment Grounding Conductor," which is defined in Article 100.

270.122(C) - Moved table - Table 270.122(C) was moved to 270.122(B) and relabeled in accordance with the NEC Style Manual. "Grounding Conductor" is no longer a defined term in the NEC, so all instances in the table were changed to "Equipment Grounding Conductor," which is defined in Article 100.

270.122(E) - Revised cross-reference - The change is made to correct the reference.

270.134 - Revised cross-reference - The cross-reference was not updated when the Correlating Committee renumbered new Article 252 to Article 270.

270.140 - Deleted the section - Frames of ranges and clothes dryers are not applicable to over 1000 V ac or 1500 V dc

270.142(B) - Revised cross-reference - The cross-reference was not updated when the Correlating Committee renumbered new Article 252 to Article 270.

270.148 - Revised cross-reference - The cross-reference was not updated when the Correlating Committee renumbered new Article 252 to Article 270.

270.148(B) - Revised text - In Article 270, the equipment grounding conductor size is not based on the overcurrent protective device; it is based on the largest ungrounded conductor in the box. The cross-reference was updated because it was not updated in the First Draft, when the Correlating Committee renumbered new Article 252 to Article 270.

Response Message: SR-8314-NFPA 70-2024

Public Comment No. 1560-NFPA 70-2024 [Section No. 270.24(A)(1)]

Public Comment No. 1489-NFPA 70-2024 [Section No. 270.32(A)]

Public Comment No. 1822-NFPA 70-2024 [Section No. 270.118(A)]

Public Comment No. 1526-NFPA 70-2024 [Section No. 270.32(D)]

Public Comment No. 1631-NFPA 70-2024 [Section No. 270.114(C)(2)]

Public Comment No. 1534-NFPA 70-2024 [Section No. 270.118(B)]

Public Comment No. 1577-NFPA 70-2024 [Section No. 270.20 [Excluding any Sub-Sections]]

Public Comment No. 1667-NFPA 70-2024 [Global Input]

Public Comment No. 1557-NFPA 70-2024 [Section No. 270.28(D)(2)]

Public Comment No. 719-NFPA 70-2024 [Section No. 270.36(E)]

Public Comment No. 1331-NFPA 70-2024 [New Section after 270.4]

Public Comment No. 1579-NFPA 70-2024 [Sections 270.20(A), 270.20(B)]

Public Comment No. 1513-NFPA 70-2024 [Section No. 270.32(D)]

Public Comment No. 1517-NFPA 70-2024 [Section No. 270.32(D)]

Public Comment No. 1979-NFPA 70-2024 [Section No. 270.14]

Public Comment No. 1559-NFPA 70-2024 [Section No. 270.24(B)(1)]

Public Comment No. 1765-NFPA 70-2024 [Section No. 270.114(C)]

Public Comment No. 1556-NFPA 70-2024 [Section No. 270.122(E) [Excluding any Sub-Sections]]

Public Comment No. 1555-NFPA 70-2024 [Section No. 270.148(B)]

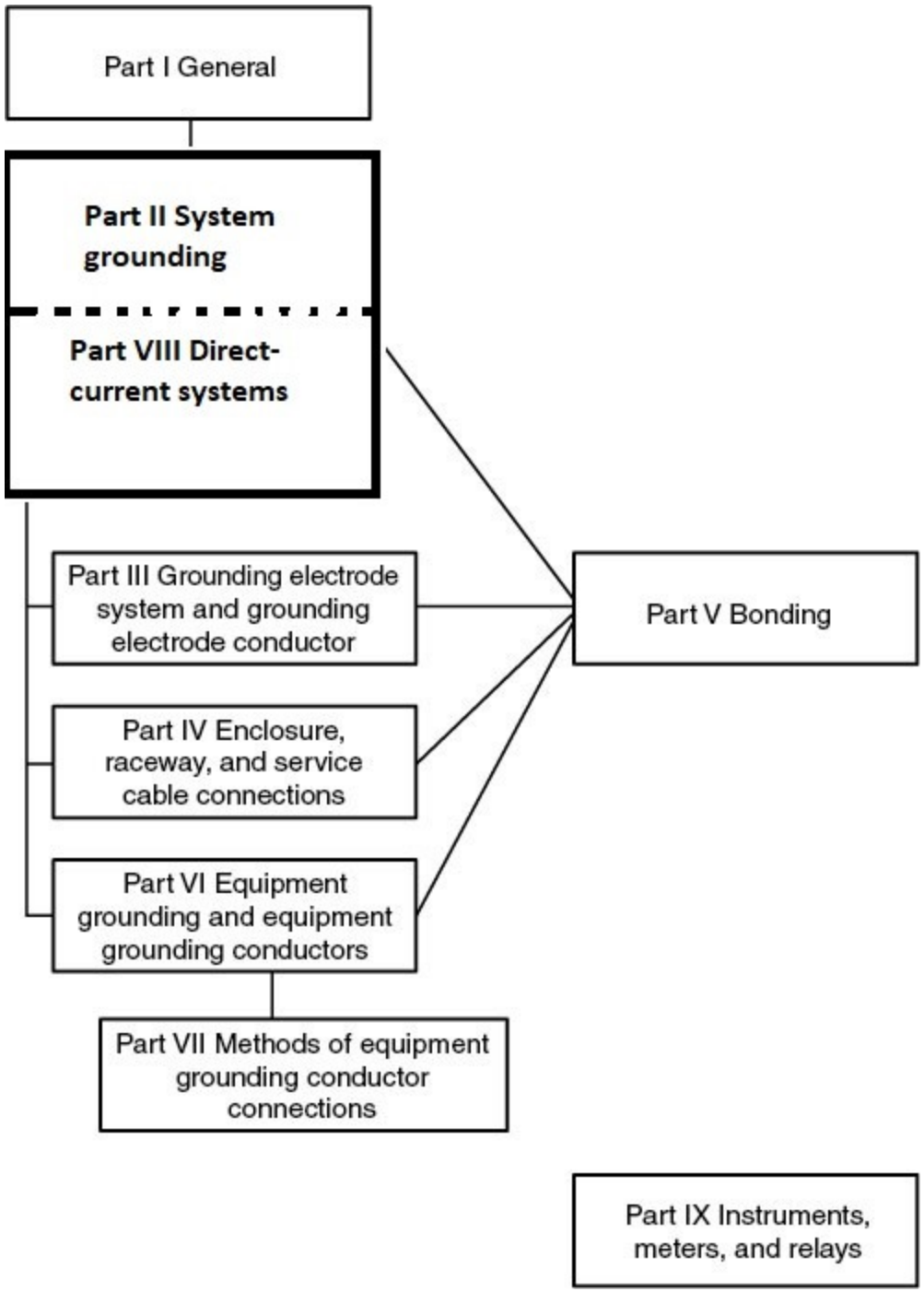
Public Comment No. 1107-NFPA 70-2024 [Section No. 270.28(B)]

Public Comment No. 1781-NFPA 70-2024 [Section No. 270.4]

Public Comment No. 1043-NFPA 70-2024 [Section No. 270.36(E)(2)]

Public Comment No. 700-NFPA 70-2024 [Article 270]

Public Comment No. 1620-NFPA 70-2024 [Section No. 270.118(A)]


Part I General
Part II System grounding
Part VIII Direct-current systems
Part III Grounding electrode system and grounding electrode conductor
Part IV Enclosure, raceway, and service cable connections
Part VI Equipment grounding and equipment grounding conductors
Part VII Methods of equipment grounding conductor connections
Part V Bonding
Part IX Instruments, meters, and relays

Second Revision No. 8238-NFPA 70-2024 [Section No. 750.2(B)]

~~**(B)** Primary and Secondary Protectors.~~

~~Primary and secondary protectors shall be listed.~~

~~Informational Note: See UL 497A-2019, *Standard for Secondary Protectors for Communications Circuits* , to determine applicable requirements for a listed secondary protector.~~

Submitter Information Verification

Committee: NEC-P05

Submittal Date: Tue Oct 22 11:16:22 EDT 2024

Committee Statement

Committee Statement: The section was deleted because the requirement has been relocated to Article 742.

Response Message: SR-8238-NFPA 70-2024

Second Revision No. 8206-NFPA 70-2024 [New Section after 750.10]

750.20 Circuits and Systems to Be Grounded.

(A) Alternating-Current (ac) Limited Energy Systems of Less Than 50 V.

Alternating-current (ac) limited-energy systems of less than 50 V shall be grounded in accordance with the applicable requirements in 250.20(A).

(B) Direct-Current (dc) Limited-Energy Systems.

Direct-current (dc) limited-energy systems shall be grounded in accordance with the applicable requirements in 250.162.

Submitter Information Verification

Committee: NEC-P05

Submittal Date: Mon Oct 21 17:58:56 EDT 2024

Committee Statement

Committee Statement: A new section 750.20 is added to point to the requirements for grounding of ac and dc systems, as both Article 250 and Article 750 cover systems that are subject to these requirements.

Response Message: SR-8206-NFPA 70-2024

Public Comment No. 958-NFPA 70-2024 [New Section after 750.10]

Second Revision No. 8223-NFPA 70-2024 [Section No. 750.60(A)]

(A) Lead-in Protectors.

If an antenna lead-in surge protector is installed, it shall be connected between the conductors and the grounded shield or other ground connection. The antenna lead-in protector shall be grounded using a bonding conductor or grounding electrode conductor installed in accordance with 750.66(F).

Informational Note: See UL 497E-2011, *Outline of Investigation for Protectors for Antenna Lead-In Conductors*, for information concerning protectors for antenna lead-in conductors.

Submitter Information Verification

Committee: NEC-P05

Submittal Date: Mon Oct 21 19:04:23 EDT 2024

Committee Statement

Committee Statement: An informational note is added to Section 750.60(A) as this note was not relocated during the first draft reorganization.

Response Message: SR-8223-NFPA 70-2024

Public Comment No. 946-NFPA 70-2024 [Section No. 750.60(A)]

Second Revision No. 8224-NFPA 70-2024 [Section No. 750.66(A)]

(A) Material.

The bonding conductor or grounding electrode conductor shall be of copper, aluminum, copper-clad steel, copper-clad aluminum, bronze, or similar corrosion-resistant material. Aluminum or copper-clad aluminum bonding conductors or grounding electrode conductors shall not be used if subject to corrosive conditions or in direct contact with masonry or the earth ~~or where subject to corrosive conditions~~ . If used outside, aluminum or copper-clad aluminum conductors shall not be installed within 450 mm (18 in.) of the earth.

Submitter Information Verification

Committee: NEC-P05

Submittal Date: Mon Oct 21 19:07:07 EDT 2024

Committee Statement

Committee Statement: The redundant text regarding corrosive environments was deleted as a first revision but not included with new Article 750.

Response Message: SR-8224-NFPA 70-2024

Public Comment No. 947-NFPA 70-2024 [Section No. 750.66(A)]

Second Revision No. 8216-NFPA 70-2024 [Section No. 750.100(A)]

(A) Bonding Conductor or Grounding Electrode Conductor.

Bonding conductors and grounding electrode conductors shall comply with 750.100 (A)(1) – through 750.100(A)(6).

(1) Insulation.

The bonding conductor or grounding electrode ~~conductor~~ shall be ~~listed and shall be~~ permitted to be insulated, covered, or bare.

(2) Material.

The bonding conductor or grounding electrode conductor shall be copper or other corrosion-resistant conductive material, stranded or solid.

(3) Size.

The bonding conductor or grounding electrode conductor shall not be smaller than 14 AWG. The bonding conductor or grounding electrode conductor shall have an ampacity not less than the aggregate of the grounded metal cable sheath member, the metal strength member(s), and the protected conductor(s) of the communications cable, conductive optical fiber cable, or the outer sheath of the coaxial cable, as applicable. The bonding conductor or grounding electrode conductor shall not be required to exceed 6 AWG.

(4) Length.

The bonding conductor or grounding electrode conductor shall be as short as practicable. In one- and two-family dwellings, the bonding conductor or grounding electrode conductor shall be as short as practicable, not to exceed 6.0 m (20 ft) in length.

Informational Note: Similar bonding conductor or grounding electrode 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. See ANSI/TIA-607-D-2019, *Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises*, which includes useful information to reduce such voltages.

Exception: In one- and two-family dwellings if it is not practicable to achieve an overall maximum bonding conductor or grounding electrode conductor length of 6.0 m (20 ft), a separate ground rod meeting the minimum dimensional criteria of 750.100(B)(3)(2) or 750.100(B)(3)(3) shall be driven, the bonding conductor or grounding electrode conductor shall be connected to the ground rod in accordance with 750.100(C), and the ground rod shall be connected to the power grounding electrode system in accordance with 750.100(D).

(5) Run in Straight Line.

The bonding conductor or grounding electrode conductor shall be run in as straight a line as practicable.

(6) Physical Protection.

Bonding conductors and grounding electrode conductors shall be protected where exposed to physical damage. If the bonding conductor or grounding electrode conductor is installed in a metal raceway, both ends of the raceway shall be bonded to the contained conductor or to the same terminal or electrode to which the bonding conductor or grounding electrode conductor is connected.

Supplemental Information

File Name	Description	Approved

SR-8216_750.100_A_.docx staff use

Submitter Information Verification

Committee: NEC-P05

Submittal Date: Mon Oct 21 18:37:46 EDT 2024

Committee Statement

Committee Statement: The listing requirements were removed from section 750.100(A)(1) to comply Style Manual 2.2.1. The listing requirement was not relocated to 750.2 because not all grounding and bonding conductors are required to be listed. The provisions of section 800.100(A)(3) were previously relocated to the new location in section 750.100(A)(2).

Response Message: SR-8216-NFPA 70-2024

Public Comment No. 948-NFPA 70-2024 [Section No. 750.100(A)]

Second Revision No. 8218-NFPA 70-2024 [Section No. 750.106]

750.~~106~~ 106 Cable and Primary Protector Grounding and Bonding at Mobile Homes.

(A) Grounding.

Grounding shall comply with 750.106(A)(1) and 750.106(A)(2).

(1) Mobile Home Service Equipment.

If there is no mobile home service equipment located within 9.0 m (30 ft) of the exterior wall of the mobile home it serves, ~~grounding shall comply with one of~~ the following ~~:The following~~ components ~~(, if present)~~ , shall be connected to a grounding electrode in accordance with 750.100(B)(3) :

(1) Primary protector grounding terminal

(2) Network interface unit

(3) Coaxial cable shield ground

(4) Surge arrester grounding terminal

(5) Network-powered broadband communications cable shield

(6) Network-powered broadband communications cable metal members not used for communications or powering

(7) The non-current-carrying metal members of optical fiber cables ~~shall be connected to a grounding electrode in accordance with 750.109(A)(1) . The network terminal, if required to be grounded, shall be connected to a grounding electrode in accordance with 251.100(A)(1)(1). The grounding electrode shall be bonded in accordance with 750.109(B) .~~

(8)

(2) Mobile Home Feeder Disconnecting Means.

If there is no mobile home disconnecting means grounded in accordance with 250.32 and located within 9.0 m (30 ft) of the exterior wall of the mobile home it serves, ~~grounding shall comply with one of~~ the following ~~:The following~~ components ~~(, if present)~~ , shall be connected to a grounding electrode in accordance with 750.100(B)(3 ~~):~~

(1) Primary protector grounding terminal

(2) Network interface unit

(3) Network-powered broadband communications shield

(4) Network-powered broadband communications cable metal members not used for communications or powering

(5) The non-current-carrying metal members of optical fiber cables ~~shall be connected to a grounding electrode in accordance with 750.109(A)(2) . The network terminal, if required to be grounded, shall be connected to a grounding electrode in accordance with 750.106(A)(2) . The grounding electrode shall be bonded in accordance with 750.109(B) .~~

(B) Bonding.

The primary protector grounding terminal or grounding electrode, network-powered broadband communications cable grounding terminal, or network interface unit grounding terminal shall be bonded together and connected to the metal frame or available grounding terminal of the mobile home with a copper conductor not smaller than 12 AWG under either of the following conditions:

(1) If there is no mobile home service equipment or disconnecting means as in 750.106(A)

(2) If the mobile home is supplied by cord and plug

Supplemental Information

File Name	Description	Approved
SR-8218_750.106.docx	staff use	

Submitter Information Verification

Committee: NEC-P05

Submittal Date: Mon Oct 21 18:49:53 EDT 2024

Committee Statement

Committee Statement: The title of Section 750.106 is revised to include the word “Cable” to make it consistent with 750.100 and to correlate with the deletion of redundant requirements in 750.116(A)-(B). Section 750.106(A) is revised to incorporate changes from section 800.106(A).

Response Message: SR-8218-NFPA 70-2024

Public Comment No. 950-NFPA 70-2024 [Section No. 750.106]

750.106 Cable and Primary Protector Grounding and Bonding at Mobile Homes.

(A) Grounding.

Grounding shall comply with 750.106(A)(1) and 750.106(A)(2).

(1) Mobile Home Service Equipment.

If there is no mobile home service equipment located within 9.0 m (30 ft) of the exterior wall of the mobile home it serves, ~~grounding shall comply with one of~~ the following components, if present, shall be connected to a grounding electrode in accordance with 750.100(B)(3):

(1) Primary protector grounding terminal
(2) Network interface unit
(3) Coaxial cable shield ground
(4) Surge arrester grounding terminal
(5) Network-powered broadband communications cable shield
(6) Network-powered broadband communications cable metal members not used for communications or powering
(7) The non-current-carrying metal members of optical fiber cables

~~(1) The following components (if present) shall be connected to a grounding electrode in accordance with 750.100(B)(3):~~

~~a. Primary protector grounding terminal~~

~~b. Network interface unit~~

~~c. Coaxial cable shield ground~~

~~d. Surge arrester grounding terminal~~

~~e. Network-powered broadband communications cable shield~~

~~f. Network-powered broadband communications cable metal members not used for communications or powering~~

~~(2) The non-current-carrying metal members of optical fiber cables shall be connected to a grounding electrode in accordance with 750.109(A)(1). The network terminal, if required to be grounded, shall be connected to a grounding electrode in accordance with 251.100(A)(1)(1). The grounding electrode shall be bonded in accordance with 750.109(B).~~

(2) Mobile Home Feeder Disconnecting Means.

If there is no mobile home disconnecting means grounded in accordance with 250.32 and located within 9.0 m (30 ft) of the exterior wall of the mobile home it serves, ~~grounding shall comply with one of~~ the following components, if present, shall be connected to a grounding electrode in accordance with 750.100(B)(3):

(1) Primary protector grounding terminal
(2) Network interface unit
(3) Network-powered broadband communications shield
(4) Network-powered broadband communications cable metal members not used for communications or powering
(5) The non-current-carrying metal members of optical fiber cables

~~(1) The following components (if present) shall be connected to a grounding electrode in accordance with 750.100(B)(3):~~

~~a. Primary protector grounding terminal~~

~~b. Network interface unit~~

~~c. Network-powered broadband communications shield~~

~~d. Network-powered broadband communications cable metal members not used for communications or powering~~

~~(2) The non-current-carrying metal members of optical fiber cables shall be connected to a grounding electrode in accordance with 750.109(A)(2). The network terminal, if required to be grounded, shall be connected to a grounding electrode in accordance with 750.106(A)(2). The grounding electrode shall be bonded in accordance with 750.109(B).~~

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(B) Bonding.

The primary protector grounding terminal or grounding electrode, network-powered broadband communications cable grounding terminal, or network interface unit grounding terminal shall be bonded together and connected to the metal frame or available grounding terminal of the mobile home with a copper conductor not smaller than 12 AWG under either of the following conditions:

(1) If there is no mobile home service equipment or disconnecting means as in 750.106(A)

(2) If the mobile home is supplied by cord and plug

Second Revision No. 8219-NFPA 70-2024 [Section No. 750.114]

750.114 Entrance Cable Bonding and Grounding.

If required, the non-current-carrying metallic members of optical fiber cables entering buildings shall be bonded or grounded as specified in 750.114(A) through 750.114(D) .

(A) Bonding Conductor or Grounding Electrode Conductor.

(1) Insulation.

The bonding conductor or grounding electrode conductor shall be listed and shall be permitted to be insulated, covered, or bare.

(2) Material.

The bonding conductor or grounding electrode conductor shall be copper or other corrosion-resistant conductive material, stranded or solid.

(3) Size.

The bonding conductor or grounding electrode conductor shall not be smaller than 14 AWG. It shall have a current-carrying capacity not less than that of the grounded metallic member(s). The bonding conductor or grounding electrode conductor shall not be required to exceed 6 AWG.

(4) Length.

The bonding conductor or grounding electrode conductor shall be as short as practicable. In one- and two-family dwellings, the bonding conductor or grounding electrode conductor shall be as short as practicable not to exceed 6.0 m (20 ft) in length.

> Informational Note: Similar bonding conductor or grounding electrode conductor length limitations applied at apartment buildings and commercial buildings help to reduce voltages that may develop between the building's power and communications systems during lightning events.

Exception: In one- and two-family dwellings if it is not practicable to achieve an overall maximum bonding conductor or grounding electrode conductor length of 6.0 m (20 ft), a separate ground rod meeting the minimum dimensional criteria of 750.114(B)(3)(2) shall be driven, the grounding electrode conductor shall be connected to the separate ground rod in accordance with 750.114(C) , and the separate ground rod shall be bonded to the power grounding electrode system in accordance with 750.114(D) .

(5) Run in Straight Line.

The bonding conductor or grounding electrode conductor shall be run in as straight a line as practicable.

(6) Physical Protection.

Bonding conductors and grounding electrode conductors shall be protected where exposed to physical damage. Where the bonding conductor or grounding electrode conductor is installed in a metal raceway, both ends of the raceway shall be bonded to the contained conductor or to the same terminal or electrode to which the bonding conductor or grounding electrode conductor is connected.

(B) Electrode.

The bonding conductor and grounding electrode conductor shall be connected in accordance with 750.114(B)(1) , 750.114(B)(2) , or 750.114(B)(3) .

(1) In Buildings or Structures with an Intersystem Bonding Termination.

If the building or structure served has an intersystem bonding termination as required by 250.94 , the bonding conductor shall be connected to the intersystem bonding termination.

Informational Note: See Figure Informational Note 800.100(B)(1) for an illustration of the application of the bonding conductor in buildings or structures equipped with an intersystem bonding termination.

(2) In Buildings or Structures with Grounding Means.

If an intersystem bonding termination is established, 250.94(A) shall apply.

If the building or structure served has no intersystem bonding termination, the bonding conductor or grounding electrode conductor shall be connected to the nearest accessible location on one of the following:

(1) The building or structure grounding electrode system as covered in 250.50

(2) The power service accessible means external to enclosures using the options identified in 250.94(A) , Exception

(3) The nonflexible metal power service raceway

(4) The service equipment enclosure

(5) The grounding electrode conductor or the grounding electrode conductor metal enclosure of the power service

(6) The grounding electrode conductor or the grounding electrode of a building or structure disconnecting means that is connected to a grounding electrode as covered in 250.32

(7) 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

Informational Note: See Figure Informational Note 800.100(B)(2) for an illustration of the application of the bonding conductor in buildings or structures not equipped with an intersystem bonding termination or terminal block providing access to the building grounding electrode system.

(3) In Buildings or Structures Without Intersystem Bonding Termination or Grounding Means.

If the building or structure served has no intersystem bonding termination or grounding means, as described in 750.114(B)(2) , the grounding electrode conductor shall be connected to either of the following:

(1) To any one of the individual grounding electrodes described in 250.52(A)(1) , 250.52(A)(2) , 250.52(A)(3) , or 250.52(A)(4) .

(2) If the building or structure served has no grounding means, as described in 750.114(B)(2) or 750.114(B)(3) (1), to any one of the individual grounding electrodes described in 250.52(A)(7) and 250.52(A)(8) or to a ground rod or pipe not less than 1.5 m (5 ft) in length and 12.7 mm ($\frac{1}{2}$ in.) in diameter, driven, where practicable, into permanently damp earth and separated from lightning protection system conductors as covered in 800.53 and at least 1.8 m (6 ft) from electrodes of other systems. Steam, hot water pipes, or lightning protection system conductors shall not be employed as electrodes for non–current-carrying metallic members.

(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 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* *750.116* .~~

~~Informational Note No. 1:~~ ~~See~~ ~~250.60~~ ~~for connection to a lightning protection system.~~

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

~~**(E)** Grounding Devices.~~

~~Where bonding or grounding is required, devices used to connect a shield, a sheath, or non-current-carrying metallic members of a cable to a bonding conductor or grounding electrode conductor shall be listed or be part of listed equipment.~~

Submitter Information Verification

Committee: NEC-P05

Submittal Date: Mon Oct 21 18:53:54 EDT 2024

Committee Statement

Committee Statement: Section 750.114 was deleted as it is redundant to the requirements in sections 750.100(A)-(D) and 750.2(A). This revision corrects the violation of the NEC Style Manual, Section 2.2.1, which requires listing requirements to be located in XXX.2.

Response Message: SR-8219-NFPA 70-2024

Public Comment No. 951-NFPA 70-2024 [Section No. 750.114]

Second Revision No. 8221-NFPA 70-2024 [Section No. 750.116]

~~**750.116** Grounding and Bonding of Entrance Cables at Mobile Homes.~~

~~**(A)** Grounding.~~

~~Grounding shall comply with 750.116(A)(1) and 750.116(A)(2) :~~

~~**(1)** Installations Without Mobile Home Service Equipment.~~

~~If there is no mobile home service equipment located within 9.0 m (30 ft) of the exterior wall of the mobile home it serves, the non-current-carrying metallic members of optical fiber cables entering the mobile home shall be grounded in accordance with 750.114(B)(3) .~~

~~**(2)** Installations Without Mobile Home Disconnecting Means.~~

~~If there is no mobile home disconnecting means grounded in accordance with 250.32 and located within 9.0 m (30 ft) of the exterior wall of the mobile home it serves, the non-current-carrying metallic members of optical fiber cables entering the mobile home shall be grounded in accordance with 750.114(B)(3) .~~

~~**(B)** Bonding.~~

~~The grounding electrode shall be bonded to the metal frame or available grounding terminal of the mobile home with a copper conductor or other equivalent corrosion-resistant material not smaller than 12 AWG under either of the following conditions:~~

(1) ~~If there is no mobile home service equipment or disconnecting means as in 750.116(A)~~

(2) ~~If the mobile home is supplied by cord and plug~~

Submitter Information Verification

Committee: NEC-P05

Submittal Date: Mon Oct 21 18:56:37 EDT 2024

Committee Statement

Committee Statement: Section 750.116 was deleted as it was redundant to the requirements in section 750.106(A)-(D).

Response Message: SR-8221-NFPA 70-2024

Public Comment No. 952-NFPA 70-2024 [Section No. 750.116]

Second Revision No. 8222-NFPA 70-2024 [Section No. 750.118]

~~**750.118** Grounding and Bonding of Cables within Buildings.~~

~~Non-current-carrying conductive members of optical fiber cables installed in buildings shall be bonded to a grounded equipment rack or enclosure, or grounded in accordance with the grounding methods specified by 750.114(B) using a conductor specified in 750.114(A) .~~

Submitter Information Verification

Committee: NEC-P05

Submittal Date: Mon Oct 21 18:57:41 EDT 2024

Committee Statement

Committee Statement: Section 750.118 was deleted as it was redundant to the requirements in section 750.108.

Response Message: SR-8222-NFPA 70-2024

Public Comment No. 953-NFPA 70-2024 [Section No. 750.118]

Second Revision No. 8352-NFPA 70-2024 [Definition: Example D14 Grounded Service Conductor]

Example D14 Grounded Service Conductor

[see 250.24(D)]

A service installation has four parallel sets of 350 kcmil ungrounded service entrance conductors. All conductors are copper. No additional considerations for adjustments or corrections are included.

(A) Parallel Grounded Service Conductors in a Single Raceway/Wireway

Section 250.24(D)(1) requires a single grounded conductor to be installed in the raceway and be not smaller than specified in Table 250.102(C)(~~2~~ 1). The size of the grounded conductor is based off the size of the equivalent area for parallel conductors.

350 kcmil × 4 = 1400 kcmil of equivalent area

According to Table 250.102(C)(~~2~~ 1), Note 1, the grounded conductor is required not be smaller than 12.5 percent of the equivalent area of the parallel ungrounded conductors.

1400 kcmil × 12.5% = 175 kcmil

The smallest standard size wire that meets this ~~criteria~~ criterion is 4/0 AWG copper.

(B) Parallel Grounded Service Conductors in Four Separate Raceways/Wireways

Section 250.24(D) states that a grounded conductor is to be routed with the ungrounded service conductors. There will be four grounded service conductors in total, one in each raceway or wireway. Section 250.24(D)(2) requires that each grounded conductor be sized in accordance with Table 250.102(C)(~~2~~ 1), based on the size of the largest ungrounded conductor in the raceway, and not smaller than 1/0 AWG. See 310.10(G) for the requirements of circuit conductors installed in parallel.

For this installation, Table 250.102(C)(~~2~~ 1) would require the installation of a ~~#2~~ 2 AWG conductor in each raceway. However, 250.24(D)(2) states that the grounded conductor installed is required to be not ~~be~~ smaller than 1/0 AWG.

A 1/0 AWG copper grounded service conductor is required to be installed in each of the four raceways containing ungrounded service conductors.

(C) Parallel Grounded Service Conductors in Two Separate Raceways/Wireways

As noted in D14(B), a grounded conductor is required to be routed with the ungrounded service conductors. In this example, two parallel sets of the 350 kcmil ungrounded service conductors will be installed in each raceway or wireway. There will be two grounded service conductors in total, one in each raceway or wireway. Section 250.24(D)(2) applies, as well as the rules in 310.10(G). With two sets installed in one raceway, the size of the grounded conductor is required to be sized in accordance with Table 250.102(C)(~~2~~ 1), and based off the equivalent area of the two sets of 350 kcmil ungrounded service conductors, or 700 kcmil.

A 2/0 AWG grounded service conductor is required to be installed in each of the two raceways containing ungrounded service conductors.

Submitter Information Verification

Committee: NEC-P05

Submittal Date: Wed Oct 23 20:14:37 EDT 2024

Committee Statement

Committee Statement:	The text was revised to create editorial improvements of the Example and fix the reference to Table 250.102(C)(1).
Response Message:	SR-8352-NFPA 70-2024

Public Comment No. 43-NFPA 70-2024 [Definition: Example D14 Grounded Service Conductor]

Second Revision No. 8201-NFPA 70-2024 [Part III.]

Part III. Grounding and Bonding Methods

750.94 Intersystem Bonding.

Intersystem bonding terminations shall be connected in accordance with 250.94(A) or 250.94(B).

Submitter Information Verification

Committee: NEC-P05

Submittal Date: Mon Oct 21 17:48:21 EDT 2024

Committee Statement

Committee Statement: The title of Article 750, Part III was revised to accommodate the new intersystem bonding section 750.94. New section 750.94 points code users to 250.94 for intersystem bonding system requirements, as intersystem bonding is applicable to both <1000-volt systems and limited-energy systems.

Response Message: SR-8201-NFPA 70-2024

Public Comment No. 975-NFPA 70-2024 [Part III.]

Public Comment No. 957-NFPA 70-2024 [New Part after III.]