CONTINUING EDUCATION FOR WISCONSIN ELECTRICIANS

2017 NEC Article 250
2 Hours

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DISCLAIMER NOTE: This course is APPROVED by the Wisconsin Department of safety and professional services for continuing education to renew your electrical license and is not intended to replace or supersede any state or local adopted codes.
Article 250.1 Scope.

Article 250 is organized into 10 different parts that deal with specific requirements with regards to bonding and grounding. The specific parts are as follows:

(I) General
(II) System Grounding AC Systems 50v to 1000v
(III) Grounding Electrode System and Grounding Electrode Conductor
(IV) Enclosure, raceway, and service Cable Grounding
(V) Bonding
(VI) Equipment grounding and Equipment grounding Conductors
(VII) Methods of Equipment Grounding
(VIII) Direct Current Systems
(IX) Instruments, Meters, Relays
(X) Grounding of Systems 1KV and Over (High Voltage)

Article 250.2 Bonding Jumper, Supply Side. A conductor installed on the supply side of a service or within a service equipment enclosure(s), or for a separately derived system, that ensures the required electrical conductivity between metal parts required to be electrically connected.

250.3 Application of Other Articles. For other articles applying to particular cases of installation of conductors and equipment, grounding and bonding requirements are identified in Table 250.3 that are in addition to, or modifications of, those of this article.

250.4 (A)(1) Electrical System Grounding. Electrical systems that are grounded are required to 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.

(NEW) 250.4(A)(1) Informational Note No. 2: See NFPA 780-2014, Standard for the Installation of Lightning Protection Systems, for information on installation of grounding and bonding for lightning protection systems.

250.4(A)(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.

250.6 (A) Arrangement to Prevent Objectionable Current. The grounding 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.

250.6 (C) Temporary Currents Not Classified as Objectionable Currents. Temporary currents resulting from abnormal conditions, such as ground faults, shall not be classified as objectionable current for the purposes specified in 250.6(A) and (B).
<table>
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| 1. | What is connecting the normally non–current-carrying electrically conductive materials that are likely to become energized together trying to establish?  
   A. An Open System  
   B. Zero potential  
   C. An effective ground fault current path  
   D. An isolating grounded system |
| 2. | What part of Article 250 deals with the grounding of high voltage equipment?  
   A. V  
   B. IV  
   C. IX  
   D. X |
| 3. | What does Article 250 NOT classify ground faults as?  
   A. Impaired currents  
   B. Objectionable currents  
   C. Temporary currents  
   D. Stray currents |
| 4. | What part of Article 250 should be used to determine methods of equipment grounding?  
   A. IX  
   B. I  
   C. VII  
   D. II |
| 5. | General information with regards to Article 250 can be found in what part?  
   A. I  
   B. II  
   C. III  
   D. IV |
| 6. | What does the supply side bonding jumper ensure between metal parts?  
   A. Power Factor corrections  
   B. Voltage Gradients  
   C. Current flow  
   D. Conductivity |
| 7. | How are the non-current metal parts of equipment required to be installed?  
   A. To eliminate Heat  
   B. To Prevent objectionable current  
   C. To control dust build up  
   D. To Eliminate voltage spikes |
| 8. | What part of Article 250 covers equipment grounding conductors?  
   A. X  
   B. IV  
   C. VI  
   D. IX |
| 9. | What table in the National Electrical Code would you find specific bonding requirements?  
   A. Article 670  
   B. Article 250.3  
   C. Article 230  
   D. No Listed Answer |
| 10. | What part of Article 250 covers information regarding Instruments, Meters, and Relays?  
    A. IX  
    B. X  
    C. VII  
    D. IV |

**250.6 (E) Isolation of Objectionable Direct-Current Ground Currents.** Where isolation of objectionable dc ground currents from cathodic protection systems is required, a listed ac coupling/dc isolating device shall be permitted in the equipment grounding conductor path to provide an effective return path for ac ground-fault current while blocking dc current.

**250.8 (B) Methods Not Permitted.** Connection devices or fittings that depend solely on solder shall not be used.

**250.10 Protection of Ground Clamps and Fittings.** Ground clamps or other fittings exposed to physical damage shall be enclosed in metal, wood, or equivalent protective covering.
250.12 Clean Surfaces. Nonconductive coatings (such as paint, lacquer, and enamel) on equipment to be grounded shall be removed from threads and other contact surfaces to ensure good electrical continuity or be connected by means of fittings designed so as to make such removal unnecessary.

250.20 (A) Alternating-Current Systems of Less Than 50 Volts. Alternating-current systems of less than 50 volts shall be grounded under any of the following conditions:

1. Where supplied by transformers, if the transformer supply system exceeds 150 volts to ground
2. Where supplied by transformers, if the transformer supply system is ungrounded
3. Where installed outside as overhead conductors

250.20 (C) Alternating-Current Systems of 1 kV and Over. Alternating-current systems supplying mobile or portable equipment shall be grounded as specified in 250.188. Where supplying other than mobile or portable equipment, such systems shall be permitted to be grounded.

250.20 (D) Impedance Grounded Neutral Systems. Impedance grounded neutral systems shall be grounded in accordance with 250.36 or 250.187.

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

250.22 Circuits Not to Be Grounded. The following circuits shall not be grounded:

1. Circuits for electric cranes operating over combustible fibers in Class III locations, as provided in 503.155
2. Circuits in health care facilities as provided in 517.61 and 517.160
3. Circuits for equipment within electrolytic cell line working zones as provided in Article 668
4. Secondary circuits of lighting systems as provided in 411.6(A)
5. Secondary circuits of lighting systems as provided in 680.23(A)(2)
6. Class 2 load side circuits for suspended ceiling low-voltage power grid distribution systems as provided in 393.60(B)

250.24 (A)(S) Load-Side Grounding Connections. A grounded conductor shall not be connected to normally non-current-carrying metal parts of equipment, to equipment grounding conductor(s), or be reconnected to ground on the load side of the service disconnecting means except as otherwise permitted in this article.

Informational Note: See 250.30 for separately derived systems, 250.32 for connections at separate buildings or structures, and 250.142 for use of the grounded circuit conductor for grounding equipment.

250.24(C)(2) Parallel Conductors in Two or More Raceways or Cables. If the ungrounded service-entrance conductors are installed in parallel in two or more raceways or cables, the grounded conductor shall also be installed in parallel. The size of the grounded conductor in each raceway or cable shall be based on the total circular mil area of the parallel ungrounded conductors in the raceway or cable, as indicated in 250.24(C)(1), but not smaller than 1/0 AWG.

(Revised) 250.30(A)(6)(C) Connections. All tap connections to the common grounding electrode conductor shall be made at an accessible location by one of the following methods:

1. A connector listed as grounding and bonding equipment.
2. Listed connections to aluminum or copper busbars not smaller than 6 mm thick × 50 mm wide (1/4 in. thick × 2 in. wide) and of sufficient length to accommodate the number of terminations necessary for the installation. If aluminum busbars are used, the installation shall also comply with 250.64(A).
3. The exothermic welding process.
11. An AC system that operates at 50 volts or less must be grounded if ________.
   A. Installed outside as overhead conductors
   B. Supplied by transformers, if the transformer supply system is ungrounded
   C. Supplied by transformers, if the transformer supply system exceeds 150 volts to ground
   D. All listed answers

12. What type of fitting that connects a grounding system cannot be used?
   A. A listed Connector
   B. One that depends solely on solder
   C. A rated connector designed for the purpose
   D. Listed split bolt

13. What is the smallest size conductor that can be used for the grounded conductor when it is run in parallel?
   A. # 3
   B. # 2
   C. 1/0
   D. #1

14. Equipment that is being grounded is required to have ________ coatings removed at the point of connection.
   A. Lacquer
   B. Paint
   C. Enamel
   D. All listed answers

15. What are circuits installed in accordance with 680.23(A) (2) not required to be?
   A. Listed
   B. Grounded
   C. Rated
   D. Identified

16. An AC system that operates at 1200 volts and supplies portable equipment is required to be grounded in accordance with ________.
   A. 250.52(A)
   B. 250.66
   C. 250.122
   D. 250.188

17. How do you determine the size of a parallel grounded conductor in a raceway?
   A. It shall be based on the total circular mil area of a single ungrounded conductor in the raceway
   B. It shall be based on the total circular mil area of the parallel ungrounded conductors in the raceway
   C. 250.122
   D. 250.102(C)

18. How many options are listed for grounding an impedance grounded neutral system?
   A. 2
   B. 3
   C. 4
   D. 1

19. How is an ungrounded system required to labeled?
   A. “Caution Look out System Operating — _____Volts Between Conductors
   B. “Caution: Do not touch System Operating — ______Volts Between Conductors”
   C. “Caution: Ungrounded System Operating — _____Volts Between Conductors”
   D. “Caution Open system Operating — _____Volts Between Conductors

20. If isolation of objectionable DC current is required, where should the dc isolating device be installed?
   A. In the grounded conductor path
   B. In the grounding conductor path
   C. In the equipment grounding conductor path
   D. In the bonding jumper path

21. Where are ungrounded systems required to be marked?
   A. First disconnecting means
   B. At the listed disconnect
   C. At the marked disconnect
   D. At the last disconnect
250.30 Grounding Separately Derived Alternating Current Systems.

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 where 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.

(Revised) 250.30(A)(4) The building or structure grounding electrode system shall be used as the grounding electrode for the separately derived system. If located outdoors, the grounding electrode shall be in accordance with 250.30(C).

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

Article 250.30(C) Grounding Separately Derived Alternating Current Systems. 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 compliance with 250.50. In addition, the installation shall comply with 250.30(A) for grounded systems or with 250.30(B) for ungrounded systems.

Article 250.32 (A) Grounding Electrode. Building(s) or structure(s) supplied by feeder(s) or branch circuit(s) shall have a grounding electrode or grounding electrode system installed in accordance with Part III of Article 250. The grounding electrode conductor(s) shall be connected in accordance with 250.32(B) or (C). Where there is no existing grounding electrode, the grounding electrode(s) required in 250.50 shall be installed.

Article 250.32 (E) Grounding Electrode Conductor. The size of the grounding electrode conductor to the grounding electrode(s) shall not be smaller than given in 250.66, based on the largest ungrounded supply conductor. The installation shall comply with Part III of this article.

Article 250.32(B)(1) Supplied by a Feeder or Branch Circuit. An equipment grounding conductor, as described in 250.118, shall be run with the supply conductors and be connected to the building or structure disconnecting means and to the grounding electrode(s). The equipment grounding conductor shall be used for grounding or bonding of equipment, structures, or frames required to be grounded or bonded. The equipment grounding conductor shall be sized in accordance with 250.122. Any installed grounded conductor shall not be connected to the equipment grounding conductor or to the grounding electrode(s).

Article 250.52(A)(1) Grounding Electrodes. Electrodes permitted for Grounding. Metal Underground Water Pipe. A metal water pipe is considered a grounding electrode if it is in contact with the earth for a minimum of 10ft. Additionally, the grounding electrode conductor is still required to connect to the metal water pipe within 5 ft of where it enters the building. The 5 ft connection rule has been moved to 250.68(C) since the 5 ft of water pipe extending out of the building is considered more of a grounding electrode conductor since it is no longer in direct contact with the earth and that portion is not considered a grounding electrode. Only the actual buried water pipe in direct connection with the earth is considered the grounding electrode.
22. In general, if a new transformer is being added to an existing system, how do you establish the grounding electrode for the new transformer?
   A. Tie into the building's existing grounding electrode system
   B. Use one ground rod installed within 6ft of the new transformer
   C. Install a ground grid with a minimum of 4 contact points
   D. Use two ground rods installed within 6ft of the new transformer

23. What section does a grounding electrode connection for ungrounded systems required to comply with?
   A. 250.66
   B. 250.32(A)
   C. 250.30(B)
   D. 250.118

24. At what location do outdoor grounding electrode connections need to be made?
   A. Property line
   B. Last Connection point
   C. The Source
   D. Utility pole

25. If a detached garage has its branch circuit installed from the house panel, the grounding electrode system for the detached garage needs to comply with what part of Article 250?
   A. V
   B. II
   C. IV
   D. III

26. What table is required to be used to size an equipment grounding conductor?
   A. 250.122
   B. 250.66
   C. 310.15a
   D. 310.16

27. How many feet does a metal water pipe need to be in direct contact with the earth to be considered a grounding electrode?
   A. 7
   B. 10
   C. 8
   D. 5

28. What Table is used to size the grounding electrode conductor to the grounding electrode(s)?
   A. 250.102(C)
   B. 250.122
   C. 250.118
   D. 250.66

29. Within how many feet of entering a structure does a grounding electrode conductor need to connect to a buried metal water pipe barring the use of any exceptions?
   A. 5
   B. 6
   C. 8
   D. 10

30. What conductor in a transfer switch needs to break to make a generator considered a separately derived system?
   A. Bonded
   B. Grounding
   C. Grounded
   D. Phase

(New) 250.52 (A)(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.
Article 250.52(A)(3) Concrete-Encased Electrode. A concrete-encased electrode shall consist of at least 6.0 m (20 ft) of either (1) or (2):

(1) One or more bare or zinc galvanized or other electrically conductive coated steel reinforcing bars or rods 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 the usual steel tie wires, exothermic welding, welding, or other effective means to create a 6.0 m (20 ft) or greater length; or

(2) Bare copper conductor not smaller than 4 AWG Metallic 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.

Article 250.53(A)(2) Supplemental Electrode Required. A single rod, pipe, or plate electrode shall be supplemented by an additional electrode of a type specified in 250.52(A)(2) through (A)(8). The supplemental electrode shall be permitted to be bonded to one of the following:

(1) Rod, pipe, or plate electrode
(2) Grounding electrode conductor
(3) Grounded service-entrance conductor
(4) Nonflexible grounded service raceway
(5) Any grounded service enclosure

Exception: If using a single electrode and the resistance is 25 ohms or less, then a supplemental electrode will not be required.

Article 250.53(A)(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.

(Revised) 250.52(A)(7) Plate Electrodes. Each plate electrode shall expose not less than 0.186 m² (2 ft²) of surface to exterior soil. Electrodes of bare or electrically conductive coated iron or steel plates shall be at least 6.4 mm (1/4 in.) in thickness. Solid, uncoated electrodes of nonferrous metal shall be at least 1.5 mm (0.06 in.) in thickness.

250.53 (D)(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.

(Revised) 250.53(F) Ground Ring. The ground ring shall be installed not less than 750 mm (30 in.) below the surface of the earth.

250.53 (H) Plate Electrode. Plate electrodes to be installed not less than 750 mm (30 in.) below the surface of the earth.
31. What is the minimum required length that a concrete encased electrode can be?
   A. 20 feet
   B. 17 feet
   C. 18 feet
   D. 16 feet

32. What is the minimum diameter where a piece of rebar can be used as a concrete encased electrode?
   A. 3/8 inch
   B. 1/2 inch
   C. 1/4 inch
   D. 3/16 inch

33. What is the minimum depth that a ground ring is required to be installed below finish grade?
   A. 36 inch
   B. 18 inch
   C. 24 inch
   D. 30 inch

34. If multiple metal in-ground support structures are present at a building or a structure, how many are required to bond into the grounding electrode system?
   A. Minimum of 1/2
   B. 1/3
   C. 1
   D. All are required to bond into the grounding electrode system

35. What shall the continuity of the grounding path or bonding connection to interior piping not rely on?
   A. Water softeners
   B. Water meters
   C. Filtering devices and similar equipment
   D. All listed answers

36. What is the minimum thickness required for a plate electrode?
   A. 1/8 in
   B. 1/2 in
   C. 3/4 in
   D. 1/4 in

37. How many feet does a structure’s steel need to be in direct contact with the earth to be used as a grounding electrode?
   A. 6
   B. 8
   C. 9 1/2
   D. 10

38. At what minimum resistance value is a supplemental electrode not required to be installed?
   A. 25 Ohms
   B. 27 Ohms
   C. 30 Ohms
   D. 43 Ohms

39. What is the minimum acceptable size that a bare copper conductor could be used as a concrete encased electrode provided it was encased in the minimum amount of concrete?
   A. 8
   B. 6
   C. 4
   D. 10

40. What is the minimum distance below finish grade that a plate electrode can be installed?
   A. 36 inches
   B. 30 inches
   C. 48 inches
   D. 24 inches

41. How much concrete needs to cover a continuous piece of bare copper conductor used as a concrete encased electrode?
   A. 1 1/4 inches
   B. 1 inches
   C. 2 inches
   D. 1/2 inches

42. How do you increase the paralleling efficiency of ground rods?
   A. Decrease the spacing by 1/2 of the longest ground rod
   B. Space them twice the length of the longest rod
   C. Space them 3 times the length of the shortest rod
   D. No listed answer
250.64(B) Securing and Protection Against Physical Damage. Where 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.

(Revised) 250.64 (B)(1) Not Exposed to Physical Damage. A 6 AWG or larger copper 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.

(Revised) 250.64 (B)(2) Exposed to Physical Damage. A 6 AWG or larger copper or aluminum grounding electrode conductor exposed to physical damage shall be protected in rigid metal conduit (RMC), intermediate metal conduit (IMC), rigid polyvinyl chloride conduit (PVC), reinforced thermosetting resin conduit Type XW (RTRC-XW), electrical metallic tubing (EMT), or cable armor.

(Revised) 250.64 (B)(3) Smaller Than 6 AWG. Grounding electrode conductors smaller than 6 AWG shall be protected in RMC, IMC, PVC, RTRC-XW, EMT, or cable armor.

Article 250.64(D)(1) Common Grounding Electrode Conductor and taps. A service that has multiple grounding electrode taps due to multiple disconnects shall connect to a common grounding electrode conductor that is connected to a common busbar for these connections. The busbar shall be at least 1/4 in. thick x 2 in. wide aluminum or copper and shall be securely fastened in an accessible location. If aluminum busbars are used, the installation shall also comply with 250.64(A). The connections to this busbar shall be made by a listed connector or by exothermic welding.

(Revised) 250.66 (A) Connections to a Rod, Pipe, or Plate Electrode(s). If the grounding electrode conductor or bonding jumper connected to a single or multiple rod, pipe, or plate electrode(s), or any combination thereof, as described in 250.52(A)(5) or (A)(7), does not extend on to other types of electrodes that require a larger size conductor, the grounding electrode conductor shall not be required to be larger than 6 AWG copper wire or 4 AWG aluminum wire.

250.68(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 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 entry. Where metal water piping is less than 1.52 m (5 ft) in length, a bonding jumper shall connect to an electrode(s) at the point of entry and the bonding jumper shall be connected to the metal underground water pipe electrode.
entrance to the building shall not be used as a conductor to interconnect electrodes of the grounding electrode system. The buried metal water pipe that is in contact with the earth can only be considered an electrode if it is in direct contact with the earth for a minimum of 10 ft.

250.92(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).

(New) 250.94 (B) Other Means. Connections to an aluminum or copper busbar not less than 6 mm thick × 50 mm wide (1/4 in. thick × 2 in. wide) and of sufficient length to accommodate at least three terminations for communication systems in addition to other connections. The busbar shall be securely fastened and shall be installed in an accessible location. Connections shall be made by a listed connector. If aluminum busbars are used, the installation shall also comply with 250.64(A).

250.98 Bonding Loosely Jointed Metal Raceways. Expansion fittings and telescoping sections of metal raceways to be made electrically continuous by equipment bonding jumpers or other means.

(Revised) 250.102 Grounded Conductor, Bonding Conductors, and Jumpers. (A) Material. Bonding jumpers shall be of copper, aluminum, copper-clad aluminum, or other corrosion-resistant material. A bonding jumper shall be a wire, bus, screw, or similar suitable conductor.

(Moved) 250.102 (C)(2) Informational Note No. 2: See Chapter 9, Table 8, for the circular mil area of conductors 18 AWG through 4/0 AWG.

EXAM QUESTIONS

46. What type of connector is required to be used when connecting grounding electrode taps to a common busbar where the grounding electrode conductor is also connected?
   A. Copper  
   B. Flanged  
   C. Listed  
   D. CO/AL

47. If using an expansion joint on a 2" aluminum conduit, what does the code require to be installed around the expansion joint?
   A. Grounding jumper  
   B. Equipment grounding conductor  
   C. Equipment bonding jumper  
   D. All listed answers

48. What is the minimum size a grounding electrode conductor not exposed to physical damage can be run along the surface of a building without metal covering or protection?
   A. 1/0  
   B. 4 AWG  
   C. 2 AWG  
   D. 6 AWG

49. If a bonding jumper to a plate electrode does not extend on to other types of electrodes that require a larger size conductor, what is the maximum size aluminum grounding electrode conductor required to be run?
   A. 6 AWG  
   B. 4 AWG  
   C. 2 AWG  
   D. 1/0

50. What table shows the circular mil area for conductors 18 AWG through 4/0 AWG?
   A. 250.122  
   B. Table 250.102(C)(1)  
   C. Table 5  
   D. Table 8

51. If using an aluminum busbar for the tap connections to a common grounding electrode conductor, what section is required to be referenced for this installation?
   A. 250.64(A)  
   B. 250.24(C)(2)  
   C. 250.30(A)(4)  
   D. 240.67
250.102 (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.

250.102 (E)(1) Inside a Raceway or an Enclosure. If installed inside a raceway, equipment bonding jumpers and bonding jumpers or conductors must comply with the requirements of 250.119 and 250.148.

250.102 (E)(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.

(Revised) 250.104 Bonding of Piping Systems and Exposed Structural Metal. (A) Metal Water Piping. The metal water piping system shall be bonded as required in (A)(1), (A)(2), or (A)(3) of this section.

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

(1) Service equipment enclosure
(2) Grounded conductor at the service
(3) Grounding electrode conductor if of sufficient size
(4) One or more grounding electrodes used, if the grounding electrode conductor or bonding jumper to the grounding electrode is of sufficient size.

The bonding jumper(s) shall be installed in accordance with 250.64(A), 250.64(B), and 250.64(E). The points of attachment of the bonding jumper(s) shall be accessible. The bonding jumper(s) shall be sized in accordance with Table 250.102(C)(1) except as permitted in 250.104(A)(2) and 250.104(A)(3).
(Revised) 250.104 (A)(3) Multiple 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 Table 250.102(C)(1), based on the size of the feeder or branch circuit conductors that supply the building or structure. The bonding jumper shall not be required to be larger than the largest ungrounded feeder or branch-circuit conductor supplying the building or structure.

(Revised) 250.104 (B) Other Metal Piping. If installed in or attached to a building or structure, a metal piping system(s), including gas piping, that is likely to become energized shall be bonded to any of the following:

1. Equipment grounding conductor for the circuit that is likely to energize the piping system
2. Service equipment enclosure
3. Grounded conductor at the service
4. Grounding electrode conductor, if of sufficient size
5. One or more grounding electrodes used, if the grounding electrode conductor or bonding jumper to the grounding electrode is of sufficient size

The bonding conductor(s) or jumper(s) shall be sized in accordance with Table 250.122, and equipment grounding conductors shall be sized in accordance with Table 250.122 using the rating of the circuit that is likely to energize the piping system(s). The points of attachment of the bonding jumper(s) shall be accessible.

(Revised) 250.104 (C) Structural Metal. Exposed structural metal that is interconnected to form a metal building frame and 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 of sufficient size
5. One or more grounding electrodes used, if the grounding electrode conductor or bonding jumper to the grounding electrode is of sufficient size

The bonding conductor(s) or jumper(s) shall be sized in accordance with Table 250.102(C)(1) and installed in accordance with 250.64(A), 250.64(B), and 250.64(E). The points of attachment of the bonding jumper(s) shall be accessible unless installed in compliance with 250.68(A) Exception No. 2.

(Revised) 250.104 (D)(2) Separately Derived Systems. Structural Metal. If exposed structural metal that is interconnected to form the building frame exists in the area served by the separately derived system, it shall be bonded to the grounded conductor of each separately derived system. This connection shall be made at the same point on the separately derived system where the grounding electrode conductor is connected. Each bonding jumper shall be sized in accordance with Table 250.102(C)(1) based on the largest ungrounded conductor of the separately derived system.

250.106 Lightning Protection Systems. The lightning protection system ground terminals to be bonded to the building or structure grounding electrode system.
57. Where is the lightning protection system of an office building required to be connected?
   A. Meter can
   B. Service enclosure
   C. Grounding electrode system
   D. All listed answers

58. What is the maximum allowable length for an equipment bonding jumper installed outside of a raceway?
   A. 5 ft
   B. 6 ft
   C. 4 ft
   D. 3 ft

59. What is the bonding jumper connection that is connected to exposed structural metal that is interconnected to form a metal building required to be?
   A. Exothermic welded
   B. Readily accessible
   C. Secured
   D. Accessible

60. What table should be used to size bonding jumpers for metal water piping systems?
   A. 250.102(C)(1)
   B. 250.122
   C. 250.104(A)(2)
   D. 250.64(A)