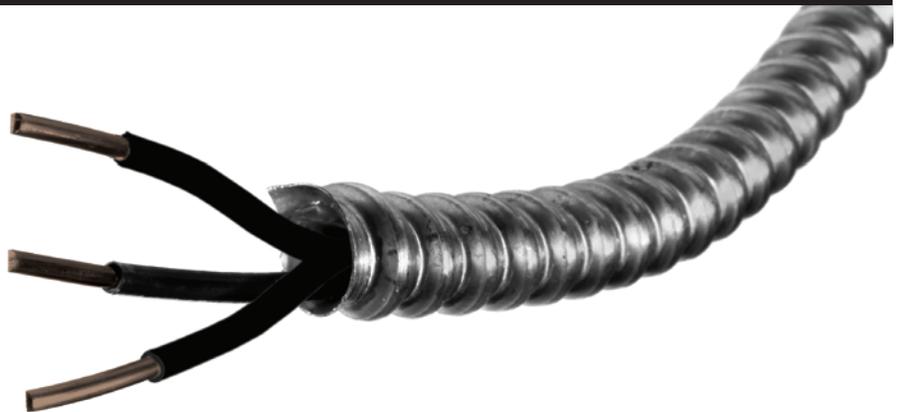




American Electrical Institute

## ARTICLE 250 GROUNDING & BONDING



**AMERICAN ELECTRICAL INSTITUTE**

N16 W23217 Stone Ridge Dr.

Waukesha, WI 53188

855-780-5046

[www.AEItraining.com](http://www.AEItraining.com)

DISCLAIMER NOTE: This course is APPROVED for continuing education to renew your electrical license and is not intended to replace or supersede any state or local adopted codes

## ARTICLE 250 GROUNDING & BONDING

### 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:

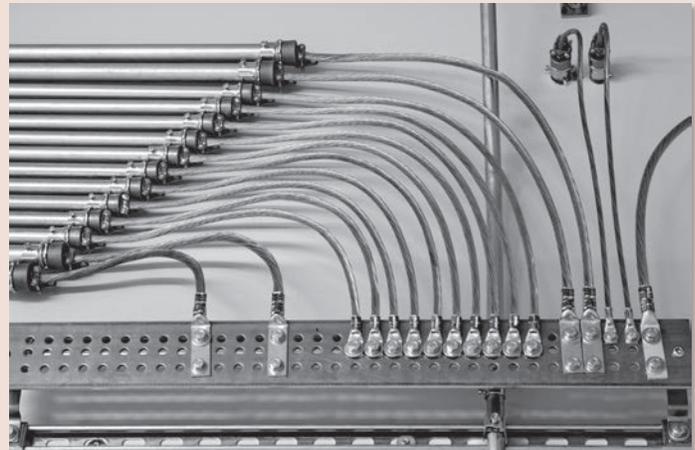
- (I) General
- (II) System Grounding
- (III) Grounding Electrode System and Grounding electrode Conductor
- (IV) Enclosure, raceway, and service Cable Grounding
- (V) Bonding
- (VI) Equipment grounding and Equipment grounding Conductors
- (VII) Methods of Equipment Grounding
- (VIII) Direct Current Systems
- (IX) Instruments, Meters, Relays
- (X) Grounding of Systems and Circuits of over 1000 Volts

### Article 250.2 Supply Side Bonding Jumper

This definition was added in the 2011 code cycle and states: 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.** The 2014 Code requires 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.



**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).

## EXAM QUESTIONS

1. A new hospital is being built that has a 13,800 volt main. The grounding and bonding for this scenario would be referenced in part \_\_\_\_\_.
  - A. V
  - B. IV
  - C. IX
  - D. X
2. An instrument transformer is required to be connected to an equipment grounding conductor, and specific requirements to accomplish this activity would be located in part \_\_\_\_\_ of article 250.
  - A. IX
  - B. X
  - C. VII
  - D. IV
3. While working at an aluminum smelter, you are asked to do all the grounding for a 200 volt direct current crane. What part of article 250 should be referenced?
  - A. V
  - B. VIII
  - C. IX
  - D. X
4. If you wanted to know the method of exactly how to ground cord and plug connected equipment, part \_\_\_\_\_ would be used.
  - A. IX
  - B. I
  - C. VII
  - D. II
5. The equipment grounding conductor required to serve a 400 amp panel would be determined in part \_\_\_\_\_ of article 250.
  - A. VI
  - B. IV
  - C. X
  - D. IX
6. Information as to ensure electrical continuity and the capacity to conduct any fault current that might be imposed through bonding would be referenced in part \_\_\_\_\_ of article 250.
  - A. IV
  - B. III
  - C. VI
  - D. V
7. How many parts is Article 250 comprised of?
  - A) 7
  - B) 10
  - C) 5
  - D) 8
8. What section of Article 250 describes the scope of the article?
  - A) 250.6 (C)
  - B) 250.4(A)(4)
  - C) 250.2
  - D) 250.1
9. What part of Article 250 would you find the correct method of bonding enclosures?
  - A) V
  - B) VI
  - C) IV
  - D) III
10. When looking for some basic general information in article 250 like definitions and basic objectives, part \_\_\_\_\_ of this article is where you would look.
  - A. II
  - B. I
  - C. III
  - D. IV
11. The supply side bonding jumper ensures electrical \_\_\_\_\_ between metal parts.
  - A. Current
  - B. Voltage
  - C. Conductivity
  - D. Power
12. Grounded systems are required to be connected to earth in such a way as to limit voltage due to \_\_\_\_\_.
  - A. Unintentional contact with higher-voltage lines
  - B. Lightning strikes
  - C. Line surges
  - D. All listed answers
13. What table in the National Electrical Code would you find specific bonding requirements?
  - A. Article 230
  - B. Article 670
  - C. Article 250.3
  - D. No listed answer

14. Non-current metal parts are required to be installed to prevent \_\_\_\_\_.

- A. Dust build up
- B. Heat
- C. Objectionable current
- D. Spikes

15. Article 250.6(A. and (B).classifies ground faults as \_\_\_\_\_.

- A. Objectionable current
- B. Temporary currents
- C. Impaired current
- D. Stray currents

16. True or False? An effective ground fault current path shall be established if non-current carrying conductive materials are likely to become energized and shall be connected together.

- A. True
- B. False

**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.** Article 250 requires the connection devices or fittings that depend solely on solder shall not be used.

**250.12 Clean Surfaces.** The 2014 code requires 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.** As required by this code, 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.** As described by article 250, 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 250.186.

**250.21(C) Ground Detectors. Marking**

Subsection (C) was added in the 2014 Code. This section requires ungrounded systems to be marked at the source of the first disconnecting means. The marking at this location shall read "Ungrounded System " and the marking must be legible and able to withstand the environment where it is located.

**250.24(C)(1)&(2) Grounded Conductor Brought to Service Equipment.**

Some verbiage changes have taken place with regards to this article concerning the grounded conductor. When installed in a single raceway, the grounded conductor cannot be smaller than the grounding electrode conductor selected from 250.66; moreover, the grounded conductor is not required to be larger than the ungrounded conductors.

If the ungrounded service conductors are installed in parallel in more than one raceway, then the grounded conductor must be installed in parallel as well. Table 250.66 will be used to select the grounded conductor based on the size of the largest service entrance conductors and shall not be smaller than 1/0 when run in parallel.



## EXAM QUESTIONS

17. If isolation of objectionable DC current is required, it must be installed in the \_\_\_\_\_ path.
- Equipment grounding conductor
  - Grounding conductor
  - Grounded conductor
  - Bonding jumper
18. A fitting used to connect a grounding system that depends solely on solder \_\_\_\_\_ be used.
- Will
  - Shall
  - Can
  - Shall not
19. Equipment that is being grounded is required to have \_\_\_\_\_ coatings removed at the point of connection.
- Lacquer
  - Paint
  - Enamel
  - All listed answers
20. An AC system that operates at 50 volts or less must be grounded if \_\_\_\_\_.
- Installed outside as overhead conductors
  - Supplied by transformers, if the transformer supply system is ungrounded
  - Supplied by transformers, if the transformer supply system exceeds 150 volts to ground
  - All listed answers
21. An AC system that operates at 1200 volts and supplies portable equipment is required to be grounded in accordance with \_\_\_\_\_.
- 250.66
  - 250.188
  - 250.122
  - 250.52(A)
22. The grounding for an impedance grounded neutral system has \_\_\_\_\_ option(s).
- 4
  - 3
  - 2
  - 1
23. Ungrounded systems are required to be marked at the \_\_\_\_\_ disconnecting means.
- New
  - First
  - Second
  - Last
24. When marking ungrounded systems, the marking shall legibly read " \_\_\_\_\_ ".
- Ungrounded system
  - Do not touch
  - Look out
  - Open system
25. Would it be considered acceptable or a violation to mark an ungrounded system located in a wet corrosive environment with un-protected normal paper?
- Acceptable
  - Violation
26. In a single raceway, the grounded conductor cannot be sized smaller than the \_\_\_\_\_.
- Grounded conductor
  - Ungrounded conductor
  - Grounding electrode conductor
  - Equipment grounding conductor
27. True or False? The grounded conductor is required to be larger than the ungrounded conductors.
- True
  - False
28. The grounding electrode conductor is sized using table \_\_\_\_\_.
- 310.16
  - 250.122
  - 250.66
  - 430.166
29. Is it required or suggested that when the ungrounded conductors are run in parallel, the grounded conductor will also be run in parallel.
- Required
  - Suggested

30. What is the smallest size conductor that can be used for the grounded conductor when it is run in parallel?

- A. #1
- B. #2
- C. #3
- D. 1/0

### 250.30 Grounding Separately Derived Alternating Current Systems. Informational Note 1

A new informational note has been added which states on site generators are not considered a separately derived system if the grounded conductor (neutral) is solidly connected to the service supplied grounded conductor. What would make a generator a separately derived system is if a transfer switch also switched the grounded conductor (neutral). A transformer is always considered a separately derived system.

### 250.30(C) Grounding Separately Derived Alternating Current Systems. Outdoor Source

If a separately derived system is located outside, a connection to one or more grounding electrodes is required at the source to comply with 250.50. The reason for connecting grounding electrodes to separately derived systems at the source is to protect them from lightning strikes and other voltage spikes that could cause damage to such sources like transformers and generators. By connecting grounding electrodes to sources in this manner, we can limit possible damage from these voltage spikes.



### 250.32(B)(1) Buildings or Structure supplied by a feeder or branch circuit.

This section requires that when a branch circuit or feeder is run to a building to supply power, a separate equipment grounding conductor is required to be run with that circuit or feeder. The equipment grounding conductor can be sized using table 250.122. The grounded conductor cannot be used for this purpose in new construction.

### 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.

## EXAM QUESTIONS

31. To make a generator considered a separately derived system, a transfer switch needs to switch the \_\_\_\_\_ conductor.

- A. Ungrounded
- B. Grounding
- C. Grounded
- D. Phase

32. A transformer is always considered a \_\_\_\_\_.

- A. Branch circuit
- B. Separately derived system
- C. Utility operated device
- D. Generator

33. The grounding electrode connections need to be made at the \_\_\_\_\_ location.
- Pole
  - Last
  - Property
  - Source
34. Grounding electrode systems help protect source equipment like transformers and generators from voltage \_\_\_\_\_.
- Spikes
  - Lags
  - Drains
  - Systems
35. Would it be considered acceptable or a violation to run an equipment grounding conductor with a circuit that is feeding a detached garage.
- Acceptable
  - Violation
36. An equipment grounding conductor shall be sized using table \_\_\_\_\_.
- 310.15a
  - 250.66
  - 250.122
  - 310.16
37. The grounded conductor can be used to ground a building in a new construction situation.
- True
  - False
38. A metal water pipe that has a minimum of \_\_\_\_\_ ft in direct contact with the earth is considered grounding electrode.
- 8
  - 7
  - 10
  - 5
39. The grounding electrode conductor is required to connect to a buried metal water pipe within \_\_\_\_\_ ft of where it enters a building barring the use of any exceptions.
- 5
  - 6
  - 8
  - 10
40. The part of a metal water pipe that extends into a building could now be considered a \_\_\_\_\_.
- Electrode
  - Grounding electrode
  - Grounding electrode conductor
  - Bonding jumper

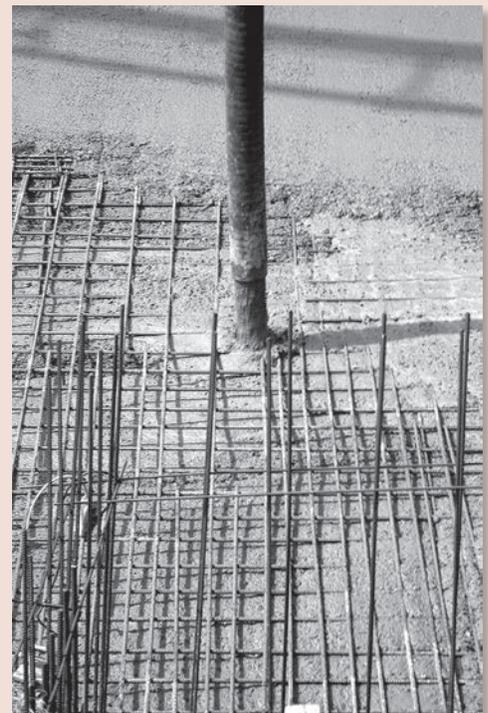
#### Article 250.52(A)(2) Metal frame of The Building or Structure.

Metal frames of buildings and structures can be used as a grounding electrode if at least one structural member is in direct contact with the earth for a minimum of 10 ft. encased or not in concrete and the hold down bolts for a column directly connect to a concrete encased electrode.

#### Article 250.52(A)(3) Concrete-Encased Electrode.

This section concerning concrete encased electrodes has been revised. A 1/2 in diameter 20 ft. long bare or galvanized steel reinforced bar is considered a concrete encased electrode. Separate pieces of rebar tied together that equal 20 ft. would also meet the requirements of a concrete encased electrode. If rebar is not available, a bare #4 copper conductor at least 20 ft long can also be used as a grounding electrode if it is encased in a minimum of 2 inches of concrete laying vertically or horizontally in a footing or column as long as the footing is in direct contact with the earth.

A new informational note has been added that indicates concrete with a vapor barrier or other film that separates the concrete from the earth is not considered in direct contact with the earth.



**Article 250.53(A)(3) Grounding Electrode Installation. Rod, Pipe and Plate electrodes. Supplemental Electrode Required**

This general rule requires when a plate electrode, pipe, or driven rod is used as an electrode, a supplemental electrode is required. The electrodes listed in 250.52(A)(2) through (A)(8) can be used as a supplemental electrode. When using a ground rod or pipe as the supplemental electrode, it shall be spaced a minimum of 6 ft. away from the first electrode.

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

**250.53 (D) (1) Continuity.** The 2011 code requires that the continuity of the grounding path or the bonding connection to interior piping shall not rely on water meters or filtering devices and similar equipment.

**250.53 (H) Plate Electrode.** Article 250 requires plate electrodes to be installed not less than 750 mm (30 in.) below the surface of the earth.

**EXAM QUESTIONS**

41. Building steel can be used as a grounding electrode if at least \_\_\_\_\_ ft. of the structure is in direct contact with the earth.
- 6
  - 8
  - 9 ½
  - 10
42. Metal frames of buildings and structures can be used as a grounding electrode if at least one structural member is in direct contact with the earth for a minimum of \_\_\_\_\_ ft. encased.
- 10
  - 6
  - 10
  - 5
43. Hold down bolts used to secure a building column can be used as a grounding electrode if the bolts are connected to the \_\_\_\_\_.
- Earth
  - Concrete
  - A PVC pipe
  - Concrete encased electrode
44. A piece of rebar 20 ft. long meets the requirement for a concrete encased electrode provided the rebar is a minimum \_\_\_\_\_ in diameter.
- 1/4 in
  - 3/8 in
  - 1/2 in
  - 3/16 in
45. A concrete encased electrode must be a minimum of \_\_\_\_\_ ft. long.
- 20
  - 17
  - 18
  - 16
46. Would it be considered acceptable or a violation to tie 2 11' pieces of rebar together with tie wire and use that as a concrete encased electrode provided the 2 pieces of rebar tied together were over 20' and the rebar was 1/2 inches in diameter.
- Acceptable
  - Violation
47. A piece of # \_\_\_\_\_ bare copper conductor could be used as a concrete encased electrode provided it was encased in the minimum amount of concrete required.
- 8
  - 6
  - 4
  - 10
48. If a continuous piece of number 4 bare copper conductor was used instead of a piece of rebar for a concrete encased electrode, the number 4 wire needs to be encased in a minimum of \_\_\_\_\_ inches of concrete.
- 2
  - 1
  - 1 1/2
  - 1/2

49. When referring a concrete encased electrode, the concrete in which an electrode is encased does not have to be in direct contact with the earth.
- True
  - False
50. When using a plate, pipe, or driven rod as an electrode, a supplemental electrode is \_\_\_\_\_.
- Purchased
  - Suggested
  - Promoted
  - Required
51. When using a rod or pipe supplemental electrode, it shall be spaced a minimum of \_\_\_\_\_ ft. from the first electrode.
- 8
  - 4
  - 6
  - 2
52. The electrodes listed in \_\_\_\_\_ can be used as a supplemental electrode.
- 210.42(A)(2.) through (A)(8)
  - 250.52(A)(2) through (A)(8)
  - 250.53(A)(3) though (A)(9)
  - No listed answers
53. If a single electrode has a resistance of \_\_\_\_\_ ohms or less, than a supplemental electrode is not required.
- 43
  - 27
  - 30
  - 25
54. Continuity of the grounding path or bonding connection to interior piping shall not rely on:
- Both B and C
  - Water meters
  - Filtering devices and similar equipment
  - Neither A nor B
55. A plate electrode shall not be installed less than \_\_\_\_\_ inches below the surface of the earth.
- 48 inches
  - 36 inches
  - 30 inches
  - 24 inches

**Article 250.64(B) Grounding Electrode Conductor Installation. Securing and protection against Physical Damage**

Grounding Electrode Conductors are now permitted to be installed through framing members. This revision takes into consideration that the framing members adequately protect the grounding electrode conductor from physical damage.

**Article 250.64(D)(1) grounding Electrode Installation. Service with Multiple Disconnecting means Enclosures. 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. x 2 in. aluminum or copper and shall be securely fastened in an accessible location. The connections to this busbar shall be made by a listed connector or by exothermic welding.

**Article 250.68(C) Conductor and Bonding Jumper Connection to Grounding Electrodes. Metallic Water Pipe and Structural Metal**

This section allows a buried metal water pipe that enters a building within 5 ft. to bond directly to building steel that is above ground. This provides a path to the grounding electrode and provides a way to tie everything into the grounding electrode system.

The metal water pipe within 5 ft of entering the building is now permitted to be used as a conductor path to connect all electrodes together that are part 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.** This section requires bonding jumpers to be used around reducing washers, oversized eccentric and concentric knockouts for conduits that contain service conductors. The code calls this an “impaired connection” and the use of bonding jumpers is required around such connections. Service conductors do not have overcurrent protection ahead of them so it is extremely important to ensure a low impedance path for any fault currents that may occur. This section now clarifies that bonding around reducing washers, oversized eccentric, and concentric knockouts are now required when raceways contain service conductors.

**250.94 Bonding for other systems.** An intersystem bonding termination point is required to be accessible to bond systems covered in 770 and Chapter 8. This point shall be installed external to enclosures at the service equipment or metering equipment enclosures as well as at the disconnecting means for other buildings and structures. Intersystem Bonding terminations are required to comply with 6 different provisions as listed in 250.94 of this code.

**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.

**250.102(A) Material.** Article 250 requires bonding jumpers to be made of copper or other corrosion-resistant material. A bonding jumper shall be a wire, bus, screw, or similar suitable conductor.



## EXAM QUESTIONS

56. Would it be acceptable or a violation to run the grounding electrode conductor for a 400 amp service through metal stud framing members?
- Acceptable
  - Violation
57. If a service has multiple disconnecting enclosures, then all the grounding electrode taps need to connect to a common \_\_\_\_\_.
- Grounded conductor
  - Grounding electrode conductor
  - Equipment grounding conductor
  - Phase conductor
58. When multiple electrode taps connect to a common busbar where the grounding electrode conductor is also connected, the busbar shall be a minimum of \_\_\_\_\_.
- 1/4 in. x 2 in.
  - 1/2 in. x 2 in.
  - 1 in. x 3 in.
  - 2 in. x 2 in.
59. When connecting grounding electrode taps to a common busbar where the common grounding electrode conductor is also connected, the approved method for attachment to the common busbar is by a \_\_\_\_\_ connector or exothermic welding.
- CO/AL
  - Designed
  - Copper
  - Listed

60. When using a common busbar for multiple grounding electrode taps connected to a common grounding electrode conductor, the busbar shall be located in an \_\_\_\_\_ location.
- Open
  - Guarded
  - Accessible
  - Shielded
61. The code allows a buried metal water pipe entering a building within \_\_\_\_\_ ft. to tie directly to building steel as to provide a path to the grounding electrode.
- 6
  - 5
  - 7
  - 10
62. For a metal water pipe to be considered a grounding electrode, it must be in direct contact with the earth for a minimum of \_\_\_\_\_ ft.
- 2
  - 5
  - 9
  - 10
63. If installing a conduit that has service conductors inside using reducing washers, the use of a \_\_\_\_\_ is now required to ensure a low impedance path for any fault currents.
- Lock nut
  - Meyer's hub
  - Bonding jumper
  - All listed answers
64. Using reducing washers, oversized concentric or eccentric knockouts without any bonding jumpers for conduits that contain service conductors is known as a (an) \_\_\_\_\_ connection.
- Grounded
  - Impaired
  - Solid
  - Bonding
65. An intersystem bonding point is required to be \_\_\_\_\_ to the metering and service equipment.
- Internal
  - External
  - Integral
  - All listed answers
66. This code has \_\_\_\_\_ different requirements for inter system bonding
- 3
  - 5
  - 6
  - 7
67. If using an expansion joint on a 2" aluminum conduit, the code requires a (an) \_\_\_\_\_ to be installed around the expansion joint.
- Equipment bonding jumper
  - Equipment grounding conductor
  - Grounding jumper
  - Both C and B
68. A bonding jumper can be a \_\_\_\_\_.
- Wire
  - Bus
  - Screw
  - All listed answers

**250.102(C)(1)&(2) Size Supply-side Bonding Jumper.** The supply side bonding jumper is installed before the service equipment overcurrent protective device and provides electrical conductivity between the metal parts of the service equipment. The supply side Bonding jumper is required to be sized using table 250.102(C) (1).. If the ungrounded supply conductors are larger than 1100 kcmil copper or 1750 kcmil aluminum, then as required by this code, the supply side bonding jumper shall be no less than 12 ½ percent of the area of the largest ungrounded supply conductor set.

**250.102 (E) Installation.** Article 250 allows bonding jumpers or conductors and equipment bonding jumpers 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.** Article 250 requires if installed on the outside of a raceway, the length of a 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.

**250.104(A)(1) General.** Metal water piping system installed in or attached to a building or structure is required to be bonded to the service equipment enclosure, the grounded conductor at the service, the grounding electrode conductor where of sufficient size, or to the one or more grounding electrodes used.

**250.104(C) Structural steel.** Bonding of piping systems and exposed structural steel. Interconnected structural steel that is likely to become energized is required by this code to be bonded to the service equipment enclosure, grounding electrode, grounding electrode conductor (if of sufficient size), and the grounded conductor at the service. This bonding jumper is required to be sized using table 250.66 and is based on the largest ungrounded branch circuit or feeder. Bonding jumper points of attachment are required to be accessible unless allowed by 250.68(A) Exception No. 2 to be covered by fireproofing material.

**250.106 Lightning Protection Systems.** The lightning protection system ground terminals to be bonded to the building or structure grounding electrode system.



## EXAM QUESTIONS

69. Table \_\_\_\_\_ is used to size the supply side bonding jumper.
- 250.122
  - 250.102(C)(1)
  - 250.104
  - 250.121
70. If you are installing 2000 Kcmil aluminum ungrounded supply conductors for a service, the supply side bonding jumper needs to be sized not less than \_\_\_\_\_% of the largest supply conductor set.
- 13
  - 12 ¼
  - 12 ½
  - 10
71. A set of 1250 kcmil copper ungrounded service entrance conductors in a single raceway would require a \_\_\_\_\_ copper supply side bonding jumper.
- 1/0
  - 3/0
  - 4/0
  - # 2
72. Would it be considered acceptable or a violation of this code to install a bonding jumper outside of a raceway.
- Acceptable
  - Violation
73. A bonding jumper is required to comply with \_\_\_\_\_ if installed in a raceway.
- 250.118
  - 250.119 and 250.148
  - 250.66 and 250.122
  - No listed answer
74. An equipment bonding jumper installed outside of a raceway cannot exceed \_\_\_\_\_ feet.
- 6
  - 5
  - 4
  - 3

75. A metal water pipe in a strip mall is required to be connected to the \_\_\_\_\_.
- Grounded conductor at the service
  - Grounding electrodes
  - Service equipment enclosure
  - All listed answers
76. True or False? The points of attachment for bonding jumpers are always required to be accessible.
- True
  - False
77. The steel of a structure that is likely to become energized is required by this code to be \_\_\_\_\_.
- Welded
  - Bonded
  - Plated
  - Coated
78. The lightning protection system of an office building is required to be connected to the \_\_\_\_\_.
- Grounding electrode system
  - Service enclosure
  - Meter can
  - All listed answers

**250.119 Identification of Equipment Grounding Conductors.** In general, an equipment grounding conductor shall be permitted to be bare, covered, or insulated. Individually covered or insulated equipment grounding conductors shall have a continuous outer finish that is either green or green with one or more yellow stripes 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.

**250.120 (B) Aluminum and Copper-Clad Aluminum Conductors.** Article 250 allows equipment grounding conductors of bare or insulated aluminum or copper-clad aluminum to be used. Bare conductors shall not come in direct contact with masonry or the earth or where subject to corrosive conditions. Aluminum or copper-clad aluminum conductors shall not be terminated within 450 mm (18 in.) of the earth.

**250.120 (C) Equipment grounding conductors smaller than 6 AWG.** Where not routed with circuit conductors as permitted in 250.130(C) and 250.134(B) 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 where not subject to physical damage.



**250.121 Use of Equipment Grounding Conductors.** An Equipment Grounding Conductor shall not be used as a Grounding Electrode Conductor. This new section was added to the 2011 Code to clarify that the Equipment Grounding Conductor and Grounding Electrode Conductors serve 2 different purposes. The grounding electrode conductor is sized using table 250.66 and connects to the grounding electrode. This conductor is often installed in parallel with the grounded conductor (Neutral) and possibly carries current under normal operation. The equipment grounding conductor is sized using table 250.122 and connects to a device or piece of equipment and provides a low impedance path for any fault current back to its source.

**250.122(B) Increased in Size.** Where ungrounded conductors are increased in size from the minimum size that has sufficient ampacity for the intended installation, wire-type equipment grounding conductors, where installed, shall be increased in size proportionately according to the circular mil area of the ungrounded conductors.

**250.122(C) Multiple Circuits.** Where a single equipment grounding conductor is run with multiple circuits in the same raceway, cable, or cable tray, it shall be sized for the largest overcurrent device protecting conductors in the raceway, cable, or cable tray. Equipment grounding conductors installed in cable trays shall meet the minimum requirements of 392.10(B)(1)(c).

## EXAM QUESTIONS

79. Article 250 allows an equipment grounding conductor to be \_\_\_\_\_.
- Bare
  - Covered
  - Insulated
  - All listed answers
80. An equipment grounding conductor with insulation is required to be \_\_\_\_\_ in color.
- Yellow
  - Green
  - Green with one or more yellow stripes
  - Both B and C
81. A Bare Aluminum equipment grounding conductor \_\_\_\_\_ come in direct contact with masonry or the earth or where subject to corrosive conditions
- Shall not
  - May
  - Can
  - All listed answers
82. An aluminum equipment grounding conductor at the main service cannot be connected closer than \_\_\_\_\_ inches to the ground.
- 20
  - 18
  - 22
  - 24
83. Would it be considered acceptable or a violation of this code to pull a single 10 AWG solid copper EGC conductor through bored holes in wood framing members to a hot water heater?
- Acceptable
  - Violation
84. Any equipment grounding conductor sized in table 250.122 is required to be protected from physical damage if it is smaller than \_\_\_\_\_ AWG
- 6
  - 8
  - 10
  - All listed answers
85. A grounding electrode conductor and an equipment grounding conductor are \_\_\_\_\_ the same conductor.
- Traditionally
  - Essentially
  - Not
  - Always
86. The grounding electrode conductor is sized using table \_\_\_\_\_.
- 250.122
  - 110.14
  - 250.66
  - 250.104
87. An equipment grounding conductor is usually installed with \_\_\_\_\_.
- Feeders
  - Branch circuits
  - Motor feeders
  - All listed answers
88. The ungrounded phase conductors for a new AC unit must be increased from 20 amps to 50 amps. This would require the equipment grounding conductor for this circuit to \_\_\_\_\_.
- Decrease
  - Increase
  - Remain the same
  - No listed answer

**89. A single equipment grounding conductor is allowed to be run with multiple circuits that share a single raceway if the equipment grounding conductor is sized to the \_\_\_\_\_.**

- A. Combined circular mils of the conductors
- B. Largest overcurrent device
- C. Type of raceway installed
- D. Raceway type

**250.122(E) Flexible Cord and Fixture Wire.** The Code requires an 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.

**250.122(G) Feeder Taps.** Equipment grounding conductors run with feeder taps shall not be smaller than shown in Table 250.122 based on the rating of the overcurrent device ahead of the feeder but shall not be required to be larger than the tap conductors.

**250.122(F) Size of Equipment grounding Conductors.** The Code has clarified this section to indicate that one equipment grounding conductor is all that is required for each parallel set of ungrounded conductors in a cable tray system. Equipment grounding conductors that are installed in cable trays are required to meet the standards as listed in 392.10(B)(1)(c). Despite this revision, equipment grounding conductors are still required to be sized using table 250.122.



**250.162 (A) Two-Wire, Direct-Current Systems.** A 2-wire, dc system supplying premises wiring and operating at greater than 60 volts but not greater than 300 volts shall be grounded.

**250.162 (B) Three-Wire, Direct-Current Systems.** Article 250 requires that the neutral conductor of all 3-wire, dc systems supplying premises wiring shall be grounded.

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

**250.166 (C) Connected to Rod, Pipe, or Plate Electrodes.** If a DC system is connected to rod, pipe, or plate electrodes as in 250.52(A)(5) or (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 wire.

## EXAM QUESTIONS

90. A manufactured flexible cord with 12 AWG wire installed cannot have an equipment grounding conductor installed smaller than \_\_\_\_\_ AWG copper.
- 10
  - 12
  - 18
  - 20
91. An equipment grounding conductor run with tap conductors for a 25hp motor \_\_\_\_\_ required to be larger than the tap conductors.
- Shall be
  - Shall not be
  - Are
  - No listed answer
92. What is the minimum size copper equipment grounding conductor required for a 400 amp subpanel in a cheese processing facility?
- # 1
  - # 2
  - # 3
  - # 6
93. A parallel set of ungrounded conductors that is pulled in a cable tray system require \_\_\_\_\_ equipment grounding conductor(s).
- Two
  - Multiple
  - One
  - No listed answer
94. Equipment grounding conductors that are installed in cable trays are required to meet the provisions of \_\_\_\_\_.
- 391.10(D)(1)(c.)
  - 391.20(B)(1)(c)
  - 392.10(D)(1)(c)
  - 392.10(B)(1)(c)
95. What is the minimum DC voltage a 2 wire system that supplies premises wiring can be before it has to be grounded?
- 24
  - 40
  - 50
  - 12
96. All 3 wire DC systems supplying premises wiring are required to be \_\_\_\_\_ regardless of voltage.
- Grounded
  - Listed
  - Open
  - Switched
97. A DC 3 wire balancer with overcurrent protection cannot have its grounding electrode conductor smaller than \_\_\_\_\_ AWG copper.
- 4
  - 6
  - 8
  - 2
98. What is the maximum size a copper grounding electrode conductor has to be when connecting a DC system to a plate electrode?
- 8 AWG
  - 6 AWG
  - 4 AWG
  - 10 AWG
99. What is the maximum size a copper grounding electrode conductor has to be when connecting a DC system to a concrete-encased electrode?
- 2 AWG
  - 6 AWG
  - 4 AWG
  - 8 AWG
100. Instrument transformers are required to be grounded if the primary windings are connected to circuits \_\_\_\_\_ volts or greater.
- 60
  - 240
  - 120
  - 300

ANSWER SHEET • ARTICLE 250 • MODULE 4

First Name: \_\_\_\_\_ Last Name: \_\_\_\_\_ Date: \_\_\_\_\_

Address: \_\_\_\_\_ City: \_\_\_\_\_ State: \_\_\_\_\_ ZIP: \_\_\_\_\_

License #: \_\_\_\_\_ Phone: \_\_\_\_\_ Email: \_\_\_\_\_

**\*\* See instructions on the inside cover page to submit your exams and pay for your course**

- |   |   |   |  |
|---|---|---|--|
| 1. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D  | 26. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 51. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 76. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D  |
| 2. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D  | 27. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 52. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 77. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D  |
| 3. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D  | 28. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 53. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 78. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D  |
| 4. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D  | 29. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 54. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 79. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D  |
| 5. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D  | 30. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 55. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 80. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D  |
| 6. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D  | 31. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 56. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 81. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D  |
| 7. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D  | 32. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 57. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 82. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D  |
| 8. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D  | 33. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 58. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 83. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D  |
| 9. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D  | 34. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 59. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 84. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D  |
| 10. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 35. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 60. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 85. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D  |
| 11. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 36. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 61. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 86. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D  |
| 12. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 37. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 62. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 87. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D  |
| 13. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 38. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 63. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 88. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D  |
| 14. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 39. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 64. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 89. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D  |
| 15. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 40. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 65. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 90. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D  |
| 16. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 41. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 66. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 91. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D  |
| 17. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 42. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 67. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 92. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D  |
| 18. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 43. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 68. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 93. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D  |
| 19. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 44. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 69. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 94. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D  |
| 20. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 45. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 70. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 95. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D  |
| 21. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 46. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 71. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 96. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D  |
| 22. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 47. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 72. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 97. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D  |
| 23. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 48. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 73. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 98. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D  |
| 24. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 49. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 74. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 99. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D  |
| 25. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 50. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 75. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D | 100. <input type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D |

