Wisconsin Contractors Institute

Article 250 Course

Course #14164 - 2 hours

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 Supply Side Bonding Jumper
This new definition was added for this 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.

Article 250.21(C) Ground Detectors. Marking
Subsection (C) was added in the 2011 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.

Article 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; furthermore, 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:

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) VI
B) IV
C) III
D) V

7) A 6x6 gutter section enclosure is attached to a panelboard with two 4 in. rigid nipples. What part of article 250 would be referenced to determine if any grounding or bonding would be required for this equipment?
A) V
B) IV
C) VII
D) X

8) A metal water pipe is in direct contact with the earth for 25 ft. What part of article 250 would you use to determine if that was appropriate for a grounding electrode system?
A) I
B) II
C) III
D) V

9) Out in the field you are tasked with the grounding of a 575 volt AC system.To determine specific methods for grounding a system such as this, part _____ of Article 250 would be used.
A) I
B) II
C) III
D) IV

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) I
B) II
C) III
D) IV

11) The supply side bonding jumper ensures electrical _____ between metal parts.
A) Current
B) Voltage
C) Conductivity
D) Power

12) Ungrounded systems are required to be marked at the _____ disconnecting means.
A) First
B) New
C) Second
D) Last

13) When marking ungrounded systems, the marking shall legibly read " _____ ".
A) Open system
B) Do not touch
C) Look out
D) Ungrounded system

14) Would it be considered acceptable or a violation to mark an ungrounded system located in a wet corrosive environment with un-protected normal paper?
A) Acceptable
B) Violation

15) In a single raceway, the grounded conductor cannot be sized smaller than the_____.
A) Equipment ground
B) Ungrounded conductor
C) Grounding electrode conductor
D) Equipment grounding conductor

16) The grounded conductor is required to be larger than the ungrounded conductors.
A) True
B) False

17) The grounding electrode conductor is sized using table_____.
A) 250.66
B) 250.122
C) 310.16
D) 430.166

18) Is it required or suggested that when the ungrounded conductors are run in parallel, the grounded conductor will also be run in parallel.
A) Required
B) Suggested

19) 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

Article 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.

Article 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.

Article 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.

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.

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.

Exam Questions:

20) 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

21) A transformer is always considered a _____.
A) Generator
B) Branch circuit
C) Utility operated device
D) Separately derived system

22) The grounding electrode connections need to be made at the _____ location.
A) Last
B) Source
C) Property
D) Pole

23) Grounding electrode systems help protect source equipment like transformers and generators from voltage _____.
A) Spikes
B) Lags
C) Drains
D) Systems

24) Would it be considered acceptable or a violation to run an equipment grounding conductor with a circuit that is feeding a detached garage.
A) Acceptable
B) Violation

25) An equipment grounding conductor shall be sized using table_____.
A) 250.66
B) 250.122
C) 310.15a
D) 310.16

26) The grounded conductor can be used to ground a building in a new construction situation.
A) True
B) False

27) A metal water pipe that has a minimum of _____ ft in direct contact with the earth is considered grounding electrode.
A) 5
B) 7
C) 8
D) 10

28) 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.
A) 5
B) 6
C) 8
D) 10

29) The part of a metal water pipe that extends into a building could now be considered a _____.
A) Grounding electrode
B) Grounding electrode conductor
C) Electrode
D) Bonding jumper

30) Building steel can be used as a grounding electrode if at least _____ ft. of the structure is in direct contact with the earth.
A) 6
B) 8
C) 9 ½
D) 10

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.

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 Code cycle has added a new section allowing 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.

Test Questions:

31) 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.
A) 5
B) 6
C) 10
D) 15

32) Hold down bolts used to secure a building column can be used as a grounding electrode if the bolts are connected to the _____.
A) Earth
B) Concrete
C) A PVC pipe
D) Concrete encased electrode

33) A piece of rebar 20 ft. long meets the requirement for a concrete encased electrode provided the rebar is a minimum _____ in diameter.
A) 3/8 in
B) 1/2 in
C) 1/4 in
D) 3/16 in

34) A concrete encased electrode must be a minimum of _____ ft. long.
A) 16
B) 17
C) 18
D) 20

35) 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.
A) Acceptable
B) Violation

36) 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.
A) 4
B) 6
C) 8
D) 10

37) 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.
A) 1/2
B) 1
C) 1 1/2
D) 2

38) 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.
A) True
B) False

39) When using a plate, pipe, or driven rod as an electrode, a supplemental electrode is _____.
A) Required
B) Suggested
C) Promoted
D) Purchased

40) When using a rod or pipe supplemental electrode, it shall be spaced a minimum of _____ ft. from the first electrode.
A) 2
B) 4
C) 5
D) 6

41) The electrodes listed in _____ can be used as a supplemental electrode.
A) 250.52(A)(2) through (A)(8)
B) 210.42(A)(2) through (A)(8)
C) 250.53(A)(3) though (A)(9)
D) None of the above

42) If a single electrode has a resistance of _____ ohms or less, than a supplimental electrode is not required.
A) 25
B) 27
C) 30
D) 43

43) Would it be acceptable or a violation to run the grounding electrode conductor for a 400 amp service through metal stud framing members?
A) Acceptable
B) Violation

44) If a service has multiple disconnecting enclosures, then all the grounding electrode taps need to connect to a common _____.
A) Equipment grounding conductor
B) Grounded conductor
C) Grounding electrode conductor
D) Phase conductor

45) When multiple electrode taps connect to a common busbar where the grounding electrode conductor is also connected, the busbar shall be a minimum of _____.
A) 1/4 in. x 2 in.
B) 1/2 in. x 2 in.
C) 1 in. x 3 in.
D) 2 in. x 2 in.

46) 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.
A) Designed
B) Listed
C) Copper
D) CO/AL

47) 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.
A) Open
B) Guarded
C) Accessible
D) Shielded

48) 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.
A) 5
B) 6
C) 7
D) 10

49) 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.
A) 2
B) 5
C) 9
D) 10

250.92(B) Method of Bonding at the service. This section now 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.

250.102(C) 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 250.66. 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.

250.104(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.

250.120 (C) Equipment grounding conductors smaller than 6 AWG. Equipment grounding conductors are required to be sized using table 250.122. 250.120 (C) requires equipment grounding conductors that are smaller than 6 AWG to be protected from physical damage by an identified raceway, cable armor, or hollow spaces in the framing that is 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(F) Size of Equipment grounding Conductors. The 2011 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.

---

50) 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.

A) Lock nut
B) Meyer's hub
C) Bonding jumper
D) All listed answers

51) Using reducing washers, oversized concentric or eccentric knockouts without any bonding jumpers for conduits that contain service conductors is known as an _____ connection.
A) Solid
B) Impaired
C) Grounded
D) Bonding

52) An intersystem bonding point is required to be _____ to the metering and service equipment.
A) Internal
B) External
C) Integral
D) All of the above

53) This code has _____ different requirements for inter system bonding.
A) 3
B) 5
C) 6
D) 7

54) Table _____ is used to size the supply side bonding jumper.
A) 250.66
B) 250.122
C) 250.104
D) 250.121

55) 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.
A) 10
B) 12 ¼
C) 12 ½
D) 13

56) A set of 1250 kcmil copper ungrounded service entrance conductors in a single raceway would require a _____ copper supply side bonding jumper.
A) 4/0
B) 3/0
C) 1/0
D) # 2

57) True or False, The points of attachment for bonding jumpers are always required to accessible.
A) True
B) False

58) The steel of a structure that is likely to become energized is required by this code to be _____.
A) Bonded
B) Welded
C) Plated
D) Coated

59) 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?
A) Acceptable
B) Violation

60) Any equipment grounding conductor sized in table 250.122 is required to be protected from physical damage if it is smaller than _____ AWG
A) 6
B) 8
C) 10
D) All of the above