American Electrical Institute

Article 250

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ANSWER SHEET • ARTICLE 250 - Oregon

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22.	Ⓐ Ⓑ Ⓒ Ⓓ	47.	Ⓐ Ⓑ Ⓒ Ⓓ	72.	Ⓐ Ⓑ Ⓒ Ⓓ	97.	Ⓐ Ⓑ Ⓒ Ⓓ
23.	Ⓐ Ⓑ Ⓒ Ⓓ	48.	Ⓐ Ⓑ Ⓒ Ⓓ	73.	Ⓐ Ⓑ Ⓒ Ⓓ	98.	Ⓐ Ⓑ Ⓒ Ⓓ
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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 Connections
(V) Bonding
(VI) Equipment grounding and Equipment grounding Conductors
(VII) Methods of Equipment Grounding Conductor connections
(VIII) Direct Current Systems
(IX) Instruments, Meters, and Relays
(X) Grounding of Systems and circuits of over 1000
This article covers general requirements for grounding and bonding of electrical installations and the following specific requirements:

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

(2) Circuit conductor to be grounded on grounded systems

(3) Location of grounding connections

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

(5) Methods of grounding and bonding

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

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

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

250.4(A)(1) Electrical System Grounding. Electrical systems that are grounded shall be connected to earth in a manner that will limit the voltage imposed by lightning, line surges, or unintentional contact with higher-voltage lines and that will stabilize the voltage to earth during normal operation.

Informational Note No. 1: An important consideration for limiting the imposed voltage is the routing of bonding and grounding electrode conductors so that they are not any longer than necessary to complete the connection without disturbing the permanent parts of the installation and so that unnecessary bends and loops are avoided.

250.4(A)(1) Informational Note No. 2: See NFPA 780-2017, 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 and bonding of electrical systems, circuit conductors, surge arresters, surge-protective devices, and conductive normally non–current-carrying metal parts of equipment shall be installed and arranged in a manner that will prevent objectionable current.

250.6(C) Currents Not Classified as Objectionable Currents. Currents resulting from abnormal conditions such as ground faults, and from currents resulting from required grounding and bonding connections shall not be classified as objectionable current for the purposes specified in 250.6(A) and (B).

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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 circuits over 1000 volts**?**

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 part of article 250 applies to enclosure, raceway, and service Cable Connections?

A) V
B) II
C) III

D) IV

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 part of article 250 would you find specific bonding requirements?

A) X
B) V
C) IV
D) IX

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

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 or bonded shall be removed from threads and other contact surfaces to ensure electrical continuity or shall be connected by means of fittings designed to make such removal unnecessary.

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) If supplied by transformers, if the transformer supply system exceeds 150 volts to ground

(2) If supplied by transformers, if the transformer supply system is ungrounded

(3) If installed outside as overhead conductors

250.20 (C) Alternating-Current Systems of over 1000 volts. Alternating-current systems supplying mobile or portable equipment shall be grounded in accordance with 250.188. If supplying other than mobile or portable equipment, such systems shall be permitted to be grounded.

250.20(D) Impedance Grounded Systems. Impedance grounded systems shall be grounded in accordance with 250.36 or 250.187, as applicable.

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.

250.24(A)(1) General. The grounding electrode conductor connection shall be made at any accessible point from the load end of the overhead service conductors, service drop, underground service conductors, or service lateral to the terminal or bus to which the grounded service conductor is connected at the service disconnecting means.
Informational Note: See Article 100 for definitions of Service Conductors, overhead; Service Conductors, Underground; Service Drop; and Service Lateral.

250.24(A)(2) Outdoor Transformer. If the transformer supplying the service is located outside the building, at least one additional grounding connection shall be made from the grounded service conductor to a grounding electrode, either at the transformer or elsewhere outside the building.
Exception: The additional grounding electrode conductor connection shall not be made on impedance grounded systems. Impedance grounded systems shall meet the requirements of 250.36 or 250.187, as applicable.

250.24(D)(2) Conductors Connected in Parallel in Two or More Raceways or Cables. If the ungrounded service-entrance conductors are connected in parallel in two or more raceways or cables, the grounded conductors shall also be installed in each raceway or cable and shall be connected in parallel. The size of each grounded conductor(s) in each raceway or cable shall not be smaller than 1/0 AWG and shall be sized in accordance with 250.24(D)(2)(a) or (D)(2)(b) in accordance with 250.24(D)(1).
(a) Shall be based on the largest ungrounded conductor in each raceway or cable.
(b) Shall be based on the sum of the circular mil areas of the largest ungrounded conductors from each set connected in parallel in each raceway or cable.
Informational Note: See 310.10(G) for grounded conductors connected in parallel.

250.30(A)(6) Grounding Electrode Conductor, Multiple Separately Derived Systems. A common grounding electrode conductor for multiple separately derived systems shall be permitted. If installed, the common grounding electrode conductor shall be used to connect the grounded conductor of each separately derived system to the grounding electrode as specified in 250.30(A)(4). A grounding electrode conductor tap shall then be installed from each separately derived system to the common grounding electrode conductor. Each tap conductor shall connect the grounded conductor of the separately derived system to the

common grounding electrode conductor. This connection shall be made at the same point on the separately derived system where the system bonding jumper is connected.

Exception No. 1: If the system bonding jumper specified in 250.30(A)(1) is a wire or busbar, it shall be permitted to connect the grounding electrode conductor tap to the equipment grounding terminal, bar, or bus, provided the equipment grounding terminal, bar, or bus is of sufficient size for the separately derived system.

Exception No. 2: A grounding electrode conductor shall not be required for a system that supplies a Class 1, Class 2, or Class 3 circuit and is derived from a transformer rated not more than 1000 volt-amperes, provided the system grounded conductor is bonded to the transformer frame or enclosure by a jumper sized in accordance with 250.30(A)(1), Exception No. 3, and the transformer frame or enclosure is grounded by one of the means specified in 250.134.

Exception No. 3: If the source of a separately derived system is located within equipment listed and identified as suitable for use as service equipment, the grounding electrode conductor from the service or feeder equipment to the grounding electrode shall be permitted as the grounding electrode conductor for the separately derived system, if the grounding electrode conductor is of sufficient size for the separately derived system. If the equipment grounding bus internal to the equipment is not smaller than the required grounding electrode conductor for the separately derived system, the grounding electrode connection for the separately derived system shall be permitted to be made to the bus.

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

(1) A conductor of the wire type not smaller than 3/0 AWG copper or 250 kcmil aluminum

(2) A metal water pipe in accordance with 250.68(C)(1)

(3) The metal structural frame of the building or structure in accordance with 250.68(C)(2) or is connected to the grounding electrode system by a conductor not smaller than 3/0 AWG copper or 250 kcmil aluminum

Tap Conductor Size. Each tap conductor shall be sized in accordance with 250.66 based on the derived ungrounded conductors of the separately derived system it serves.

Exception to (a)(1) and (b): If the only electrodes that are present are of the types in 250.66(A), (B), or (C), the size of the commongrounding electrode

conductor shall not be required to be larger than the largest conductor required by 250.66(A), (B), or (C) for the type of electrode that is present.
(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 be in accordance with 250.64(A).
(3) The exothermic welding process.
Tap conductors shall be connected to the common grounding electrode conductor in such a manner that the common grounding electrode conductor remains without a splice or joint.

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 depend 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) **In what article does the 2023 code list the definition for service conductors?**

A) 220
B) 100
C) 310
D) 440

16) Alternating-current systems supplying mobile or portable equipment shall 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 sum of the circular mil areas of the largest ungrounded conductors from each set connected in parallel in each raceway or cable
C) 250.122
D) 250.102(C)

18) Impedance grounded systems shall meet the requirements of_____,

A) 250.36 or 250.187
B) 220.20

C) 215.12
D) 230.34 or 230.114

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) What code section has additional information for grounded conductors connected in parallel?

A) 310.10(G)
B) 220.8(B)
C) 250.18(G)
D) 315.10(D)

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 if the alternate source transfer equipment does not include a switching action in the grounded conductor and allows it to remain solidly connected to the service-supplied grounded conductor when the alternate source is operational and supplying the load served.

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) Outdoor Source. If the source of the separately derived system is located outside the building or structure supplied, a grounding electrode connection shall be made at the source location to one or more grounding electrodes in accordance with 250.50. In addition, the installation shall be in accordance with 250.30(A) for grounded systems or with 250.30(B) for ungrounded systems.
Exception: The grounding electrode conductor connection for impedance grounded systems shall be in accordance with 250.36 or 250.187, as applicable.

Article 250.32 (A) Grounding Electrode System and Grounding Electrode Conductor. A building(s) or structure(s) supplied by a feeder(s) or branch circuit(s) shall have a grounding electrode system and grounding electrode conductor installed in accordance with Part III of Article 250. Where there is no existing grounding electrode, the grounding electrode(s) required in 250.50 shall be installed.
Exception: A grounding electrode system and grounding electrode conductor shall not be required if only a single branch circuit, including a multiwire branch circuit, supplies the building or structure and the branch circuit includes an equipment grounding conductor for grounding the normally non–current-carrying metal parts of equipment.

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 250.32 (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.

250.52(A)(1) Metal Underground Water Pipe.
A metal underground water pipe in direct contact with the earth for 3.0 m (10 ft) or more (including any metal well casing bonded to the pipe) and electrically continuous (or made electrically continuous by bonding around insulating joints or insulating pipe) to the points of connection of the grounding electrode conductor and the bonding conductor(s) or jumper(s), if installed.

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 buildings 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

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

Metal components shall be encased by at least 50 mm (2 in.) of concrete and shall be located horizontally within that portion of a concrete foundation or footing that is in direct contact with the earth or within vertical foundations or structural components or members that are in direct contact with the earth. If multiple concrete-encased electrodes are present at a building or structure, it shall be permissible to bond only one into the grounding electrode system.
Informational Note: Concrete installed with insulation, vapor barriers, films or similar items separating the concrete from the earth is not considered to be in "direct contact" with the earth.

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.

250.52(A)(5) Plate Electrodes. Plate electrodes shall be installed not less than 750 mm (30 in.) below the surface of the earth.

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.

250.53(E) Supplemental Grounding Electrode Bonding Jumper Size.
Where the supplemental electrode is a rod, pipe, or plate electrode, that portion of the bonding jumper that is the sole connection to the supplemental grounding electrode shall not be required to be larger than 6 AWG copper wire or copper clad aluminum wire.

250.53(F) Ground Ring. The ground ring shall 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 size copper conductor that can be used as a bonding jumper to a supplemental plate electrode where it is the sole connection to the supplemental grounding electrode?**

A) 10 AWG
B) 8 AWG
C) 4 AWG
D) 6 AWG

37) How many feet does a structures steel need to be in direct contact with the earth to be used as a grounding electrode?

A) 6
B) 8
C) 9 ½
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 AWG
B) 6 AWG
C) 4 AWG
D) 10 AWG

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 ½ 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

43) What is the minimum distance that supplemental electrodes are required to be spaced from each other?

A) 6 ft.
B) 4 ft.
C) 5 ft.
D) 2 ft.

44) Where do you find what is considered an acceptable supplemental electrode?

A) 250.53(A)(3) though (A)(9)
B) 210.42(A)(2) through (A)(8)
C) 250.52(A)(2) through (A)(8)
D) No listed answer

45) What can cause concrete to not be considered in "direct contact" with the earth?

A) Films
B) Insulation
C) Vapor barriers
D) All listed answers

250.64(B) Securing and Protection Against Physical Damage. If exposed, a grounding electrode conductor or its enclosure shall be securely fastened to the surface on which it is carried. Grounding electrode conductors shall be permitted to be installed on or through framing members.

250.64 (B)(1) Not Exposed to Physical Damage. A 6 AWG or larger copper, copper-clad aluminum or aluminum grounding electrode conductor not exposed to physical damage shall be permitted to be run along the surface of the building construction without metal covering or protection.

250.64 (B)(2) Exposed to Physical Damage. A 6 AWG or larger copper, copper-clad aluminum or aluminum grounding electrode conductor exposed to physical damage shall be protected in rigid metal conduit (RMC), intermediate metal conduit (IMC), Schedule 80 rigid polyvinyl chloride conduit (PVC), reinforced thermosetting resin conduit Type XW (RTRC-XW), electrical metallic tubing (EMT), or cable armor.

250.64 (B)(3) Smaller Than 6 AWG. Grounding electrode conductors smaller than 6 AWG shall be protected in RMC, IMC, Schedule 80 PVC, RTRC-XW, EMT, or cable armor.

250.64(D)(1) Common Grounding Electrode Conductor and Taps.
A common grounding electrode conductor and grounding electrode conductor taps shall be installed. The common grounding electrode conductor shall be sized in accordance with 250.66, based on the sum of the circular mil area of the largest ungrounded conductor(s) of each set of conductors that supplies the disconnecting means. If the service-entrance conductors connect directly to the overhead service conductors, service drop, underground service conductors, or service lateral, the common grounding electrode conductor shall be sized in accordance with Table 250.66, note 1.
A grounding electrode conductor tap shall extend to the inside of each disconnecting means enclosure. The grounding electrode conductor taps shall be sized in accordance with 250.66 for the largest service-entrance or feeder conductor serving the individual enclosure. The tap conductors shall be connected to the

common grounding electrode conductor by one of the following methods in such a manner that the common grounding electrode conductor remains without a splice or joint:
(1) Exothermic welding.
(2) Connectors listed as grounding and bonding equipment.
(3) Connections to an aluminum or copper busbar not less than 6 mm thick × 50 mm wide (1⁄4 in. thick × 2 in. wide) and of sufficient length to accommodate the number of terminations necessary for the installation. The busbar shall be securely fastened and shall be installed in an accessible location. Connections shall be made by a listed connector or by the exothermic welding process. If aluminum busbars are used, the installation shall comply with 250.64(A).

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 copper-clad 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, as measured along the water piping, shall be permitted to extend the connection to an electrode(s). Interior metal water piping located more than 1.52 m (5 ft) from the point of entrance to the building, as measured along the water piping, shall not be used as a conductor to interconnect electrodes of the grounding electrode system.
Exception: In industrial, commercial, and institutional buildings or structures, if conditions of maintenance and supervision ensure that only qualified persons service the installation, interior metal water piping located more than 1.52 m (5 ft) from the point of entrance to the building, as measured along the water piping, shall be permitted as a bonding conductor to interconnect electrodes that are part of the grounding electrode system, or as a grounding electrode conductor, if the entire length, other than short sections passing perpendicularly through walls, floors, or ceilings, of the interior metal water pipe that is being used for the conductor is exposed.

(2) The metal structural frame of a building shall be permitted to be used as a conductor to interconnect electrodes that are part of the grounding electrode system, or as a grounding electrode conductor. Hold-down bolts securing the structural steel column that are connected to a concrete-encased
electrode complying with 250.52(A)(3) and located in the support footing or foundation shall be permitted to connect the metal structural frame of a building or structure to the concrete encased grounding electrode. The hold-down bolts shall be connected to the concrete-encased electrode by welding, exothermic welding, the usual steel tie wires, or other approved means.
(3) A rebar-type concrete-encased electrode installed in accordance
with 250.52(A)(3) with an additional rebar section extended from its location within the concrete foundation or footing to an accessible location that is not subject to corrosion shall be permitted for connection of grounding electrode conductors and bonding jumpers in accordance with the following:
a. The additional rebar section shall be continuous with the grounding electrode rebar or shall be connected to the grounding electrode rebar and connected together by the usual steel tie wires, exothermic welding, welding, or other effective means.
b. The rebar extension shall not be exposed to contact with the earth without corrosion protection.
c. Rebar shall not be used as a conductor to interconnect the electrodes of grounding electrode systems.

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).

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

(1) Bonding equipment to the grounded service conductor by an applicable method in 250.8(A)

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

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

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

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). The busbar shall be connected to the grounding electrode system by a conductor that is the larger of the following:

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

(2) As required or permitted in 250.94(A)

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

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

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

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.

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.

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 that 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

52) What code section is a common grounding electrode conductor used with tap conductors required to be sized?

A) 250.52(A)(3)

B) 250.122
C) 250.66
D) 250.102(C)

53) If a service has multiple disconnecting enclosures, where do all the grounding electrode taps need to connect to?

A) A common grounded conductor
B) A common grounding electrode conductor
C) A common equipment grounding conductor
D) Any phase conductor

54) Where are communications system bonding terminations required to be installed if using a busbar?

A) At each server rack for testing and maintenance

B) In the communications room

C) In the main electrical service room next to the service concrete encased electrode

D) In an accessible location

55) What is the minimum size busbar required when multiple electrode taps connect to a common busbar where the grounding electrode conductor is also connected?

A) 1/2 in. x 2 in.
B) 1/4 in. x 2 in.
C) 1 in. x 3 in.
D) 2 in. x 2 in.

56) What is the minimum size grounding electrode conductor that must be protected from physical damage by RMC, IMC, PVC, RTRC-XW, EMT, or cable armor?

A) 8 **AWG**

B) 6 **AWG**

C) 4 **AWG**

D) No Special requirement

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 shall 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.

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

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 250.104(A)(1), (A)(2), or (A)(3) of this section.

250.104(A)(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), (B), and (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 that it shall not be required to be larger than 3/0 copper or 250 kcmil aluminum or copper-clad aluminum and except as permitted in 250.104(A)(2) and (A)(3).

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

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.

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 not smaller than a conductor sized in accordance with Table 250.102(C)(1)

(5) One or more grounding electrodes used, if the grounding electrode conductor or bonding jumper to the grounding electrode is not smaller than a conductor sized in accordance with Table 250.102(C)(1)

The bonding conductor(s) or jumper(s) shall be sized in accordance with Table 250.102(C)(1) except that it shall not be required to be larger than 3/0 AWG copper or 250 kcmil aluminum or copper-clad aluminum and installed in accordance with 250.64(A), (B), and (E). The points of attachment of the bonding jumper(s) shall be accessible unless installed in compliance with 250.68(A) Exception No. 2.

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. except that it shall not be required to be larger than 3/0 AWG copper or 250 kcmil aluminum or copper-clad aluminum.

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) In general, 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 installed in or attached to a building?

A) 250.102(C)(1)

B) 250.122

C) 250.104(A)(2)

D) 250.64(A)

61) What section(s) are bonding jumpers required to comply with if installed in a raceway?

A) 250.66 and 250.122

B) 250.118

C) 250.119 and 250.148

D) No listed answer

62) What is the bonding jumper connection to a metal water pipe installed in a building required to be?

A) Readily accessible

B) Accessible

C) Secured

D) Exothermic welded

63) What table should be used to size the bonding jumpers for metal gas piping systems?

A) 250.64(A)

B) 250.102(C)(1)

C) 250.104(A)(2)

D) 250.122

64) Where do you make the connection inside a transformer for the conductor that bonds the exposed structural metal that is interconnected to form a building frame?

A) On the transformer case

B) At the equipment grounding conductor connection

C) At the grounding electrode conductor connection

D) To all corners where the isolation pads are being installed

250.119 Identification of Wire-Type Equipment Grounding Conductors(A) General. Unless required elsewhere in this Code, equipment grounding conductors shall be permitted to be bare, covered, or insulated. Individually covered or insulated equipment grounding conductors 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.

250.119 (C) Flexible Cord. Equipment grounding conductors in flexible cords shall be insulated and shall have a continuous outer finish that is either green or green with one or more yellow stripes.

250.120(B) Aluminum and Copper-Clad Aluminum Conductors.

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

(1) Unless part of an applicable cable wiring method, bare or covered conductors shall not be installed if subject to corrosive conditions or be installed in direct contact with concrete, masonry, or the earth.

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

(3) Aluminum or copper-clad aluminum conductors external to buildings or enclosures shall not be terminated within 450 mm (18 in.) of the earth, unless terminated within a listed wire connector system.

250.120 (C) Equipment grounding conductors smaller than 6 AWG. If not routed with circuit conductors as permitted in 250.130(C) and 250.134

Exception No. 2, equipment grounding conductors smaller than 6 AWG shall be protected from physical damage by an identified raceway or cable armor unless installed within hollow spaces of the framing members of buildings or structures and if not subject to physical damage.

250.122(A) General. Copper, aluminum, or copper-clad aluminum equipment grounding conductors of the wire type shall not be smaller than shown in Table 250.122. The equipment grounding conductor shall not be required to be larger than the circuit conductors supplying the equipment. If a cable tray, a raceway, or a cable armor or sheath is used as the equipment grounding conductor, as provided in 250.118 and 250.134(1), it shall comply with 250.4(A)(5) or (B)(4).

Equipment grounding conductors shall be permitted to be sectioned within a multiconductor cable, provided the combined circular mil area complies with. Table 250.122.

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

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

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

65) What type of conductor can an equipment grounding conductor to be?

A) Bare

B) Covered

C) Insulated

D) All listed answers

66) How is an equipment grounding conductor with insulation required to be identified?

A) Green phase tape

B) Green

C) Green with one or more yellow stripes

D) All listed answers

67) What is the equipment grounding conductor installed in a flexible cord required to be?

A) Compact copper

B) Insulated

C) 12 AWG minimum

D) All listed answers

68) What is the minimum distance from ground that an aluminum equipment grounding conductor at the main service can be connected?

A) 18 inches

B) 20 inches

C) 22 inches

D) 24 inches

69) At what size is an equipment grounding conductor using table 250.122 required to be protected from physical damage?

A) 8 AWG

B) 6 AWG

C) 10 AWG

D) All listed answers

70) Copper, aluminum, or copper-clad aluminum equipment grounding conductors of the wire type shall not be smaller than shown in Table_____.

A) 250.66
B) 250.122

C) 250.102(C)1
D) 250.104

71) What code section has the minimum requirements for installing equipment grounding conductors in cable trays?

A) 250.66

B)| 250.104

C) 392.10(B)(1)(c)
D) 250.122

72) The ungrounded phase conductors for a new AC unit must be increased from 20 amps to 50 amps. What would the equipment grounding conductor for this circuit have to do?

A) Increase

B) Decrease

C) Remain the same

D) No listed answer

73) How is a single equipment grounding conductor run with multiple circuits that share a single raceway required to be sized?

A) Based on the combined circular mils of the conductors

B) Based on the largest overcurrent device

C) Based on the type of raceway installed

D) Based on the raceway conductivity

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

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

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

(b)Multiple Raceways. If conductors are installed in multiple raceways and are connected in parallel, a wire-type equipment grounding conductor, if used, shall be installed in each raceway and shall be connected in parallel. The equipment grounding conductor installed in each raceway shall be sized
in accordance with 250.122 based on the rating of the overcurrent protective device for the feeder or branch circuit.

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

(d) Metal Raceways, Auxiliary Gutters, or Cable Trays. Metal raceways or auxiliary gutters in accordance with 250.118 or cable trays complying with 392.60(B) shall be permitted as the equipment grounding conductor.

250.122(F)(2) Multiconductor Cables.

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

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

(c) If multiconductor cables are paralleled in the same raceway, auxiliary gutter, or cable tray, a single equipment grounding conductor that is sized in accordance with 250.122 shall be permitted in combination with the equipment grounding conductors provided within the multiconductor cables and shall all be connected together.
(d) Equipment grounding conductors installed in cable trays shall meet the minimum requirements of 392.10(B)(1)(c). Cable trays complying with 392.60(B), metal raceways in accordance with 250.118, or auxiliary gutters shall be permitted as the equipment grounding conductor.

250.122(G) Feeder Taps.
Equipment grounding conductors installed 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 on the supply side ahead of the tap but shall not be required to be larger than the tap conductors.

250.146 Connecting Receptacle Grounding Terminal to an Equipment Grounding Conductor.
An equipment bonding jumper shall be used to connect the grounding terminal of a grounding-type receptacle to a metal box that is connected to an equipment grounding conductor, except as permitted in 250.146(A) through (D). The equipment bonding jumper shall be sized in accordance with 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. The neutral conductor of all 3-wire, dc systems supplying premises wiring shall be grounded.

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

74) What is required of the neutral conductor in all 3 wire DC systems supplying premises wiring?

A) Switched separately
B) Must be listed
C) Required to be fixed
D) Must be grounded

75) What is the minimum size equipment grounding conductor required for a manufactured flexible cord with 12 AWG wire installed?

A) 10 AWG

B) 12 AWG

C) 18 AWG

D) 20 AWG

76) What table is required to be used to size a wiretype equipment grounding conductor used in a cable tray?

A) 250.122
B) 250.102(C)(1)
C) 250.104(A)(2)
D) 250.66

77) What section should be referenced to determine the minimum installation requirements for equipment grounding conductors installed in a cable tray?

A) 250.122(F)(2)(b)
B) 392.10(B)(1)(c)
C) 250.118
D) 392.60(B)

78) What is the minimum size copper grounding electrode conductor for a DC 3 wire balancer with overcurrent protection?

A) 2 AWG

B) 6 AWG

C) 4 AWG

D) 8 AWG

79) At what minimum DC voltage is a 2-wire system that supplies premises wiring required to be grounded?

A) 60

B) 50

C) 24

D) 12

80) How many provisions must be met where a grounded box does not need to connect to a grounding-type receptacle?

A) 1
B) 3
C) 4
D) 2

81) How do you determine the minimum required size equipment grounding conductor run with feeder taps?

A) 250.66
B) Needs to be based on the rating of the overcurrent device downstream of the feeder
C) 250.102(C)
D) Needs to be based on the rating of the overcurrent device ahead of the feeder

250.166 (C) Connected to Rod, Pipe, or Plate Electrodes. If 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 or copper-clad aluminum wire.

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

250.170 Instrument Transformer Circuits. The secondary circuits of current and potential instrument transformers shall be grounded if the primary windings are connected to circuits of 300 volts or more to ground and, where on switchboards, shall be grounded irrespective of voltage.

250.172 Instrument Transformer Cases. Cases or frames of instrument transformers shall be connected to the equipment grounding conductor if accessible to other than qualified persons.

250.174 Cases of Instruments, Meters, and Relays Operating at 1000 Volts or Less. Instruments, meters, and relays operating with windings or working parts at less than 1000 volts shall be connected to the equipment grounding conductor as specified in 250.174(A), (B), or (C).

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

250.176 Cases of Instruments, Meters, and Relays — Operating at over 1000 Volts and Over. If instruments, meters, and relays have current-carrying parts of over 1000 volts and over to ground, they shall be isolated by elevation or protected by a barrier(s), grounded metal, or insulating covers or guards. Their cases shall not be connected to the equipment grounding conductor.

250.178 Instrument Equipment Grounding Conductor. The equipment grounding conductor for secondary circuits of instrument transformers and for instrument cases shall not be smaller than 12 AWG copper or 10 AWG aluminum or copper-clad aluminum. Cases of instrument transformers, instruments, meters, and relays that are mounted directly on grounded metal surfaces of enclosures or

grounded metal switchboard panels shall not be required to be connected to an additional equipment grounding conductor.

250.182 Derived Neutral Systems. A system neutral point derived from a grounding transformer shall be permitted to be used for grounding systems over 1 kV.

250.184 Solidly Grounded Neutral Systems. Solidly grounded neutral systems shall be permitted to be either single point grounded or multi-grounded neutral.

250.184 (A)(1) Insulation Level. The minimum insulation level for a neutral conductor in a solidly grounded system shall be 600 volts.

250.184 (A)(2) Ampacity. The neutral conductor shall have an ampacity that is not less than the load imposed and be not less than 33⅓ percent of the ampacity of the phase conductors.

250.184 (A)(2) Exception: In industrial and commercial premises under engineering supervision, it shall be permissible to size the ampacity of the neutral conductor to not less than 20 percent of the ampacity of the phase conductor.

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

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

(2) Ground detectors are installed on the system.

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

Impedance grounded systems shall comply with 250.187(A) through (D).

250.187(B) Insulated. The impedance grounding conductor shall be insulated for the maximum neutral voltage.

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

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

250.186 Ground-Fault Circuit Conductor Brought to Service Equipment. (A) Systems with a Grounded Conductor at the Service Point. If an ac system is grounded at any point and is provided with a grounded conductor at the service point, a grounded conductor(s) shall be installed and routed with the ungrounded conductors to each service disconnecting means and shall be connected to each disconnecting means grounded conductor(s) terminal or bus. A main bonding jumper shall connect the grounded conductor(s) to each service disconnecting means enclosure. The grounded conductor(s) shall be installed in accordance with 250.186(A)(1) through (A)(4). The size of the solidly grounded circuit conductor(s) shall be the larger of that determined by 250.184 or 250.186(A)(1) or (A)(2).

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

250.186 (A)(1) Single Raceway or Overhead Conductor. The grounded conductor shall not be smaller than the required grounding electrode conductor specified in Table 250.102(C)(1) but shall not be required to be larger than the largest ungrounded service-entrance conductor(s).

250.191 Grounding System at Alternating-Current Substations. For ac substations, the grounding system shall be in accordance with Part III of this article

82) What is the smallest allowable aluminum equipment grounding conductor for secondary circuits of instrument transformers?

A) 10 AWG
B) 12 AWG
C) 14 AWG
D) 16 AWG

83) What are the frames of instrument transformers required to be connected to if other than qualified persons have access to them?

A) Grounded conductor
B) Grounding electrode conductor
C) Equipment grounding conductor
D) An isolated phase inverter

84) What percentage of its phase conductor does the ampacity of a neutral conductor in a solidly grounded system required to be?

A) 25 percent
B) 33 percent
C) 33 1/3 percent
D) 125 percent

85) What is a relay that has current-carrying parts of 1200 volts to ground required to be?

A) Elevated
B) Isolated
C) Protected
D) All listed answers

86) What is the maximum size a copper grounding electrode conductor has to be when connecting a DC system to a plate electrode?

A) 4 AWG

B) 8 AWG

C) 6 AWG

D) 10 AWG

87) A system neutral point derived from a grounding transformer can be used for grounding systems over what voltage?

A) 480 volts
B) 600 volts
C) 575 volts
D) 1000 volts

88) What should the maximum neutral voltage in a threephase wye system be?

A) 57.7 percent of the phase-to-ground voltage

B) 57.7 percent of the phase-to-phase voltage

C) 125% of the primary neutral voltage

D) 125% of the primary voltage

89) What is the minimum insulation value required for a neutral conductor in a solidly grounded system?

A) No requirement
B) 600 volts
C) 575 volts
D) 480 volts

90) What is the maximum size a copper grounding electrode conductor must be when connecting a DC system to a concrete-encased electrode?

A) 2 AWG

B) 6 AWG

C) 8 AWG

D) 4 AWG

91) In an oil refinery where engineers supervise a solidly grounded system, the neutral conductor is allowed to be sized at what percent of its phase conductors current?

A) 20 percent
B) 33 percent
C) 33 1/3 percent
D) 125 percent

92) How many provisions must be met to use an impedance grounded system?

A) 1

B) 2

C) 3

D) There are no requirements

93) Instrument transformers are required to be grounded if the primary windings are connected to circuits _____ volts or greater.

A) 60

B) 240

C) 120

D) 300

94) At what voltage does a relay need to have its case connected to an equipment grounding conductor **if** accessible to other than qualified persons**?**

A) 300 volts

B) 240 volts

C) 120 volts

D) 60 volts

95) What is a relay with operating parts of 600 volts required to be connected to?

A) No requirement
B) Grounding electrode conductor
C) Grounded conductor
D) Equipment grounding conductor

96) How does an impedance grounded system limit the ground-fault current?

A) With the use of a Capacitor

B) With the use of a Resistor

C) With the use of an Inductor

D) With the use of a Resonance Inhibitor

97) What part of article 250 is required to be referenced when installing the grounding systems for alternating current substations?

A) IV

B) III

C) X

D) VI

98) What can a single assembly used as service equipment containing 2 or more disconnects connect the grounded conductor(s) to?

A) Equipment case

B) Isolated

C) Common terminal

D) All listed answers

99) What is required to connect the grounded conductor(s) of each service disconnecting means enclosure?

A) Grounding electrode conductor

B) Current transformer

C) Grounding Conductor

D) Main bonding jumper

100) True or False? A grounding electrode conductor is generally required to be larger than the largest ungrounded service-entrance conductor.

A) True

B) False