bobo technologies

NEC® 2020

Electrical Continuing Education

Instructor and Course Detail
Code Changes
Grounding and Bonding
Wiring Methods
Theory and Calculations

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National Electrical Code® 2020
Continuing Education

Course Approval Request
Code Changes/Grounding – 8 Hours
Electrical Theory & Calculations - 8 Hours
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Division of Professions and Occupations

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10/01/2017
Issue Date

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09/30/2020
Expire Date

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1876

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Division of Professions and Occupations

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SECTION 2

Code Changes 4 Hours / Grounding and Bonding 4 Hours

NEC2020 Changes - 4 Hours

The course curriculum covers 2020 Changes in Chapters 1-5, as well as their practical application throughout the NEC.
We also highlight the most significant changes that have been implemented.

NEC2020 Grounding and Bonding – 4 Hours

This course covers grounding and bonding definitions in Article 100 and highlights Article 250.1 through 250.104.

Following are sample pages of material covered in the classroom and online.

• Article 100 Definitions – New Definition for Dormitory Unit

Dormitory Unit. A building or a space in a building in which group sleeping accommodations are provided for more than 16 persons who are not members of the same family in one room, or a series of closely associated rooms, under joint occupancy and single management, with or without meals, but without individual cooking facilities. (CMP-2)

Comment: The term "dormitory" was used eight times in the 2017 NEC and is used nine times in the NEC® 2020. 210.12(B) requires that all 120-volt, single-phase, 15- and 20-ampere branch circuits supplying outlets and devices installed in dormitory unit bedrooms, living rooms, hallways, closets, bathrooms, and similar rooms have arc-fault circuit-interrupter protection. 406.12(7) requires that all 15- and 20-ampere, 125- and 250-volt nonlocking-type receptacles installed in dormitory units be tamper-resistant. Without a clear definition of a dormitory unit, the installer and AHJ cannot determine what type of facilities these requirements would apply to. Typically, a dormitory is in connection with an educational facility, but this definition can also apply to other types of structures. Some examples might be lodges, orphanages, or homeless shelters that meet the requirements of this definition. For example, a cabin that provided sleeping accommodations for a maximum of 12 unrelated people, would not be considered a dormitory, even though it met all the other requirements of the definition.

• Article 100 Definitions – New Definition for Available Fault Current

Fault Current, Available (Available Fault Current). The largest amount of current capable of being delivered at a point on the system during a short-circuit condition. (CMP-10)
Informational Note: A short-circuit can occur during abnormal conditions such as a fault between circuit conductors or a ground fault. See Informational Note Figure 100.1.

Comment: The definition of available fault current is taken from SR8 of NFPA70E (Standard for Electrical Safety in the Workplace) – 2018. Most electrical faults start out as ground faults and then evolve into phase-to-phase faults. Fault current is typically several times larger than normal current flow since the only limiting impedance is that of the distribution system. Faults can be caused by such things as insulation failure, equipment failure, weather damage, animals, or human error. Faults can be interrupted by devices such as fuses, circuit breakers, or relays.

• Article 100 Definitions – New Informational Note for Grounded Conductor

Grounded Conductor. A system or circuit conductor that is intentionally grounded. (CMP-5)

Informational Note: Although an equipment grounding conductor is grounded, it is not considered a grounded conductor.

Comment: An equipment grounding conductor is defined as "A conductive path(s) that is part of an effective ground-fault current path and connects normally non-current-carrying metal parts of equipment together and to the system grounded conductor or to the grounding electrode conductor, or both." Although the EGC is typically connected to the grounded conductor, it does not normally carry current except under fault conditions. The grounded conductor carries current under normal operation. The grounded conductor may or may not be a neutral conductor, depending on whether it is connected to the neutral point. In the case of a 3-phase, 3-wire, corner-grounded delta-connected system, the grounded conductor is grounded, but it is not considered a neutral. In addition to carrying normal current, the grounded conductor also carries fault current from the EGC from the point where they are connected together by the main bonding jumper, to the neutral point on the transformer.

• Article 100 Definitions – New Definition for Habitable Room.

Habitable Room. A room in a building for living, sleeping, eating, or cooking, but excluding bathrooms, toilet rooms, closets, hallways, storage or utility spaces, and similar areas. (CMP-2)

Comment: Although habitable room was mentioned in several places in the NEC® 2017, it was not defined. This new definition for a habitable room is consistent with NFPA 5000, *Building Construction and Safety Code*. An example of where habitable rooms are addressed in the NEC is 210.70(A)(1) **Habitable Rooms**. It states that, "At least one lighting outlet controlled by a listed wall-mounted control device shall be installed in every habitable room, kitchen, and bathroom. The wall-mounted control device shall be located near an entrance to the room on a wall." In addition, 404.2(C) **Switches Controlling Lighting Loads** says, "The grounded circuit conductor for the controlled lighting circuit shall be installed at the location where switches control lighting loads that are supplied by a grounded general-purpose branch circuit serving bathrooms, hallways, stairways, and habitable rooms or occupiable spaces as defined in the applicable building code."

• Identification of Disconnecting Means

110.22(A) General. Each disconnecting means shall be legibly marked to indicate its purpose unless located and arranged so the purpose is evident. In other than one- or two-family dwellings, the marking shall include the identification of the circuit source that supplies the disconnecting means. The marking shall be of sufficient durability to withstand the environment involved.

Comment: Disconnecting means installed in other than one- or two-family dwellings are now required to have the circuit source supplying the disconnect identified in addition to the purpose of the disconnect, unless the purpose is evident. This marking shall be of sufficient durability to withstand the environment involved, such as wet locations. This is similar to the requirement in 408.4(B) for switchboards, switchgear, and panelboards to identify the device or equipment where the power originates. This new requirement for disconnects includes the actual circuit source, and not just the general location of where the power source originates.

• Entrance to an Egress from Working Space

110.26(C)(2) Large Equipment. For large equipment that contains overcurrent devices, switching devices, or control devices, there shall be one entrance to and egress from the required working space not less than 24 in. wide and 6 1/2 ft. high at each end of the working space. This requirement shall apply to either of the following conditions:

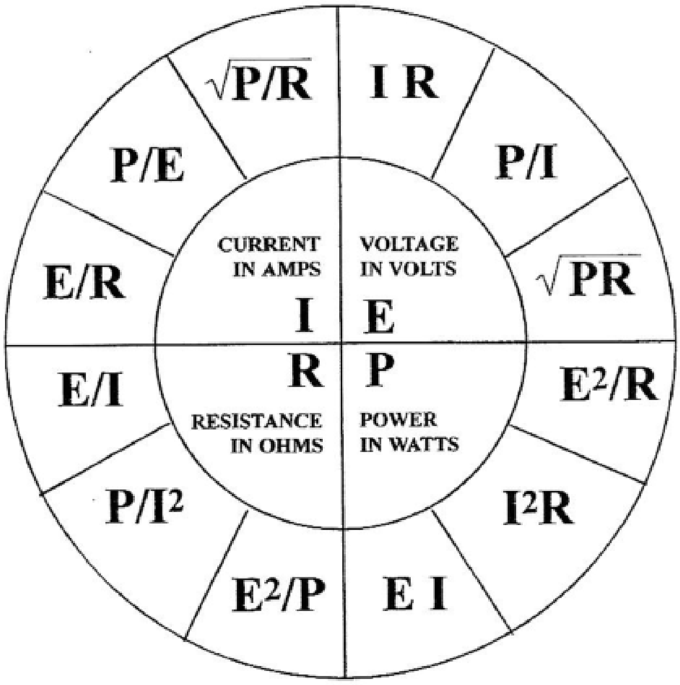
(1) For equipment rated 1200 amperes or more and over 6 ft. wide

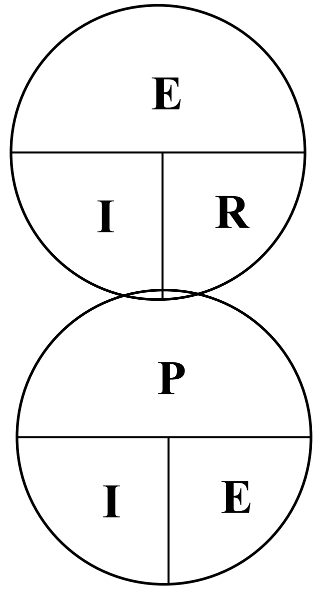
(2) For service disconnecting means installed in accordance with 230.71 where the combined ampere rating is 1200 amperes or more and over 6 ft. wide

Open equipment doors shall not impede the entry to or egress from the working space.

Comment: Large equipment now includes the original requirement of equipment rated 1200 amperes or more and over 6 feet wide, as well as service disconnecting means where the combined ampere rating is 1200 amperes or more, and the combined width is over 6 feet. For example, two 800 ampere service disconnects with a width of 4 feet each are now considered large equipment because of their combined ampere ratings and combined widths exceed 1200 amperes and 6 feet. In addition, an open equipment door cannot obstruct the entry to or egress from the required working space for large equipment. Revisions to 230.71(B) no longer allow more than one service disconnecting means in the same panelboard or enclosure. Each service disconnect must be in a separate enclosure.

Formulas





d is made up of 3 components:

2. X_L Inductive reactance
3. X_c Capacitive reactance

IMPEDANCE FORMULA

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

VOLTAGES:

Unless other voltages are specified for purposes of computing branch circuit and feeder loads, nominal system voltages of 120, 120/240, 208Y/120, 240, 347, 480Y/277, 480, 600Y/347, and 600 volts shall be used. (220.5(A), Informative Annex D)

CALCULATED LOAD:

For reasonable precision, volt-ampere calculations are carried to three significant figures only; where loads are converted to amperes the results are rounded to the nearest ampere [see 220.5(B)].
Informative Annex D Example D3 (a) Calculated Load

FRACTIONS OF AN AMPERE:

Calculations shall be permitted to be rounded to the nearest whole ampere, with decimal fractions smaller than 0.5 dropped. (220.5(B), Informative Annex D)

Sizing Grounding Conductors

ARTICLE 100 DEFINITIONS:

Ground - The earth. (CMP-5)

Grounded **(Grounding)** Connected (connecting) to ground or to a conductive body that extends the ground connection. (CMP-5)

Grounded Conductor - A system or circuit conductor that is intentionally grounded (e.g., neutral conductor). (CMP-5)

Grounding Conductor, Equipment (EGC)- A conductive path(s) that is part of an effective ground-fault current path and connects normally noncurrent-carrying metal parts of equipment, together and to the system grounded conductor or to the grounding electrode conductor, or both. (CMP-5)

Grounding Electrode - A conducting object through which a direct connection to earth is established. (CMP-5)

Grounding Electrode Conductor - A conductor used to connect the system grounded conductor or the equipment to a grounding electrode or to a point on the grounding electrode system. (CMP-5)

Bonded (Bonding) - Connected to establish electrical continuity and conductivity. (CMP-5)

Bonding Conductor or Jumper - A reliable conductor to ensure the required electrical conductivity between metal parts required to be electrically connected. (CMP-5)

Bonding Jumper, Equipment - The connection between two or more portions of the equipment grounding conductor. (CMP-5)

Bonding Jumper, Main - The connection between the grounded circuit conductor and the equipment grounding conductor, or the supply-side bonding jumper, or both at the service. (CMP-5)

Bonding Jumper, System - The connection between the grounded circuit conductor and the equipment supply-side bonding jumper, or the equipment grounding conductor, or both, at a separately derived system. (CMP-5)

Neutral Point - The common point on a wye-connection in a polyphase system or midpoint on a single-phase, 3-wire system, or midpoint of a single-phase portion of a 3-phase delta system, or a midpoint of a 3-wire, direct-current system. (CMP-5)

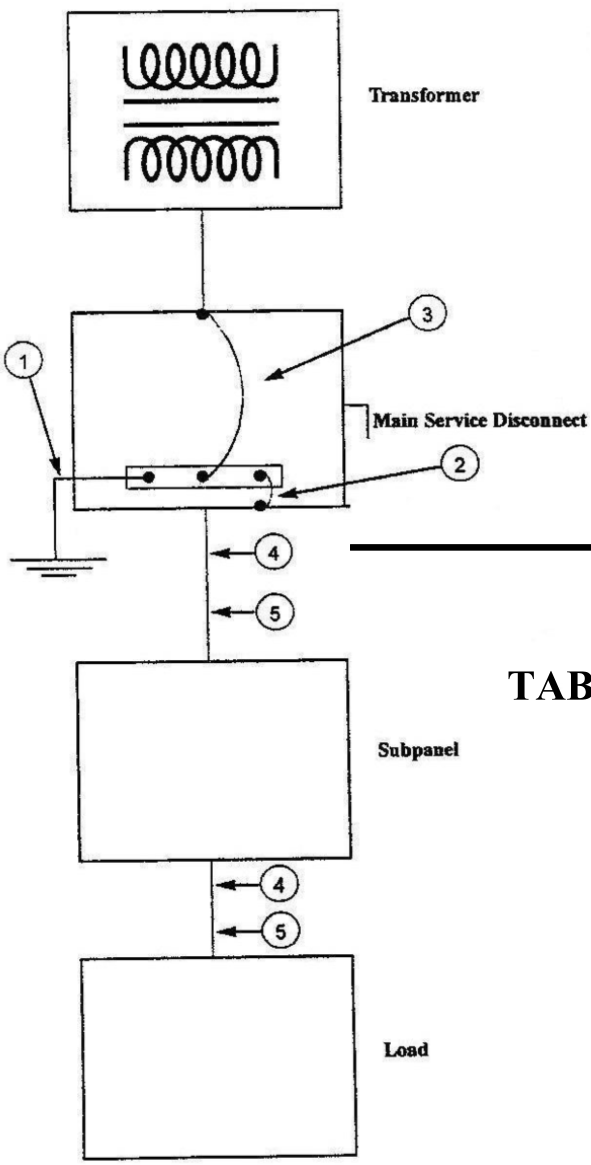
Neutral Conductor - The conductor connected to the neutral point of a system that is intended to carry current under normal conditions. (CMP-5)

Sizing Grounding Conductors

TABLE 250.66 and TABLE 250.102(C)(1)

1. **Grounding Electrode Conductor**
   250.66, Table 250.66
   Sized to largest ungrounded service-entrance conductor or equivalent area for parallel conductors.
   (Maximum size 3/0 copper or 250 kcmil aluminum.)

TABLE 250.102(C)(1)



2. **Main Bonding Jumper** 250.28(D)(1), Table 250.102(C)(1)
   Sized to largest ungrounded service-entrance conductor or equivalent area for parallel conductors.
   (Not less than 12½% of largest phase conductor)

3. **Supply-Side Bonding Jumper** 250.102(C), 250.92, Table 250.102(C)(1)
   Sized to largest ungrounded service-entrance conductor in each raceway or cable.
   (Not less than 12½% of largest phase conductor.)

TABLE 250.122

4. **Equipment Bonding Jumper on Load Side of an Overcurrent Device** 250.102(D), Table 250.122
   Sized to largest overcurrent device supplying circuits contained in raceway or cable.

5. **Equipment Grounding Conductor** 250.122(A), Table 250.122
   Sized to largest overcurrent device supplying circuits contained in raceway or cable.

Minimum Size of Copper Grounded Conductor (Usually Neutral)
Installed in a single raceway 250.24 (C)(2), Table 250.102(C)(1)

Service Ampere Rating	Total kcmil Area of Copper Ungrounded Conductors	Minimum kcmil Area of Copper Grounded Conductor	Minimum Size of Copper Grounded Conductor
1000	3 Runs of (3) 400 kcmil = _____kcmil Cu	________kcmil Cu	________AWG Cu
1200	4 Runs of (3) 350 kcmil = _____kcmil Cu	________kcmil Cu	________AWG Cu
1600	5 Runs of (3) 400 kcmil = _____kcmil Cu	________kcmil Cu	________kcmil Cu
2000	6 Runs of (3) 400 kcmil =_____kcmil Cu	________kcmil Cu	________kcmil Cu

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Minimum Size Copper Grounding Electrode Conductor for Service, Separately Derived System, or Feeder Supply

Type of Electrode: Metal Water Pipe, Building Steel 250.52 (A)(1)(2), 250.66, Table 250.66

100 AMP 3 AWG Cu ________ AWG Cu

200 AMP 3/0 AWG Cu ________ AWG Cu

400 AMP 500 kcmil Cu ________ AWG Cu

800 AMP 2 Runs 600 kcmil Cu ________ AWG Cu

Type of Electrode: Rod, Pipe, or Plate 250.52 (A)(5), 250.66 (A), Table 250.66

100 AMP 3 AWG Cu ________ AWG Cu

200 AMP 3/0 AWG Cu ________ AWG Cu

400 AMP 500 kcmil Cu ________ AWG Cu

800 AMP 2 Runs 600 kcmil Cu ________ AWG Cu

Minimum Size Copper Grounding Electrode Conductor for Service, Separately Derived System, or Feeder Supply

Type of Electrode: Concrete-Encased
250.52 (A)(3), 250.66 (B), Table 250.66

100 AMP 3 AWG Cu ________ AWG Cu

200 AMP 3/0 AWG Cu ________ AWG Cu

400 AMP 500 kcmil Cu ________ AWG Cu

800 AMP 2 Runs 600 kcmil Cu ________ AWG Cu

Type of Electrode: Ground Ring – 2 AWG Cu
250.52 (A)(4), 250.66 (C), Table 250.66

100 AMP 3 AWG Cu ________ AWG Cu

200 AMP 3/0 AWG Cu ________ AWG Cu

400 AMP 500 kcmil Cu ________ AWG Cu

800 AMP 2 Runs 600 kcmil Cu ________ AWG Cu

Type of Electrode: Ground Ring – 250 kcmil Cu
250.52 (A)(4), 250.66 (C), Table 250.66

100 AMP 3 AWG Cu ________ AWG Cu

200 AMP 3/0 AWG Cu ________ AWG Cu

400 AMP 500 kcmil Cu ________ AWG Cu

800 AMP 2 Runs 600 kcmil Cu ________ AWG Cu

A. TABLE 250.66

I. Grounding Electrode Conductor (250.66, Table 250.66)

If available on the premises at each building or structure served, each of the following items shall be bonded together to form the grounding electrode system:

1. Metal Underground Water Pipe
2. Metal In-ground Support Structure(s)
3. Concrete-Encased Electrode
4. Ground Ring
5. Rod and Pipe Electrodes
6. Other Listed Electrodes
7. Plate Electrodes
8. Other Local Metal Underground Systems or Structures

250.52(A)(1) through (A)(8)

Where none of the above electrodes exist or where only a metal underground water pipe is available, one or more of the following electrodes shall be installed and used:

1. Ground Ring
2. Rod and Pipe Electrodes
3. Other Listed Electrodes
4. Plate Electrodes
5. Other Local Metal Underground Systems or Structures

250.50, 250.52(A)(4) through (A)(8)

A metal underground water pipe, rod, pipe, or plate electrode shall be supplemented by an additional electrode of a type specified in 250.52(A)(2) through (A)(8). 250.53(A)(2), 250.53 (D)(2)

The size of the grounding electrode conductor of an ac system and the bonding jumper between grounding electrodes shall not be less than given in Table 250.66 (250.66, 250.50), 250.53 (C).

250.66 Size of Alternating-Current Grounding Electrode Conductor
The size of the grounding electrode conductor at the service, at each building or structure where supplied by a feeder(s) or branch circuit(s), or at a separately derived system of a grounded or ungrounded ac system shall not be less than given in Table 250.66, except as permitted in 250.66(A) through (C).

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

(B) Connections to Concrete-Encased Electrodes.
If the grounding electrode conductor or bonding jumper connected to a single or multiple concrete-encased electrode(s), as described in 250.52(A) (3), does not extend on to other types of electrodes that require a larger size of conductor, the grounding electrode conductor shall not be required to be larger than 4 AWG copper wire.

(C) Connections to Ground Rings.
If the grounding electrode conductor or bonding jumper connected to a ground ring, as described in 250.52(A) (4), does not extend on to other types of electrodes that require a larger size of conductor, the grounding electrode conductor shall not be required to be larger than the conductor used for the ground ring.

1. Problem: What size copper grounding electrode conductor run to a metal water pipe is required for a 400 amp service fed by (4) 600 kcmil THW copper conductors?
   Solution: 250.66, Table 250.66

   Answer: 1/0 copper

2. Problem: What size copper grounding electrode conductor run as a sole connection to a supplemental ground rod would be required for the previous question?
   Solution: 250.53(D)(2), 250.53(E), 250.66(A)

   Answer: 6 AWG copper

3. Problem: What size THW aluminum grounding electrode conductor run to building steel is required for a 500 amp service fed with (3) THW aluminum conductors terminated on 75° C lugs?
   Solution: 1500 kcmil THW aluminum for 500 amps Table 310.16
   Table 250.66

   Answer: 4/0 THW aluminum

4. Problem: What size copper bonding jumper is required between building steel and a metal water pipe for a 200 amp service fed with (3) 3/0 AWG THW copper conductors?
   Solution: 250.104(C), Table 250.66

   Answer: 4 AWG copper

II. Size -- Main Bonding Jumper

The main bonding jumper shall not be smaller than specified in Table 250.102(C)(1). Where the service-entrance phase conductors are larger than 1100 kcmil copper or 1750 kcmil aluminum, the bonding jumper shall have an area that is not less than 12½ percent of the area of the largest phase conductor except that where the phase conductors and the bonding jumper are of different materials (copper or aluminum), the minimum size of the bonding jumper shall be based on the assumed use of phase conductors of the same material as the bonding jumper and with an ampacity equivalent to that of the installed phase conductors. 250.28 (D)(1), Table 250.102(C)(1) and Note 1

1. Problem: What size copper main bonding jumper is required for a main service fed with (4) 250 kcmil THW copper conductors?
   Solution: 250.28(D)(1), Table 250.102(C)(1)

   Answer: 2 AWG copper

2. Problem: What size copper main bonding jumper is required for a main service fed with 6 parallel runs of (4) 500 kcmil THHN copper conductors?

Solution: 500 × 6 runs = 3000 kcmil — 250.28(D)(1), Table 250.102(C)(1)
3000 kcmil × 12½% = 375 kcmil — and Note 1
Next standard size = 400 kcmil — Table 310.16

Answer: 400 kcmil copper

III. Size – Supply-Side Bonding Jumper.

(1) Size for Supply Conductors in a Single Raceway or Cable. The supply-side bonding jumper shall not be smaller than specified in Table 250.102(C)(1). Where the ungrounded supply conductors are larger than 1100 kcmil copper or 1750 kcmil aluminum, the supply-side bonding jumper shall have an area not less than 12½ percent of the area of the largest set of ungrounded supply conductors. 250.102(C)(1), Table 250.102(C)(1) and Note 1

(2) Size for Parallel Conductor Installations in two or more raceways. Where the ungrounded supply conductors are paralleled in two or more raceways or cables, and an individual supply-side bonding jumper is used for bonding theses raceways or cables, the size of the supply-side bonding jumper for each raceway or cable shall be selected from Table 250.102(C)(1) based on the size of the ungrounded supply conductors in each raceway or cable. A single supply-side bonding jumper installed for bonding two or more raceways or cables shall be sized in accordance with 250.102(C)(1).

If the ungrounded supply conductors and the supply-side bonding jumper are of different materials (copper or aluminum), the minimum size of the supply-side bonding jumper shall be based on the assumed use of ungrounded conductors of the same material as the supply-side bonding jumper and will have an ampacity equivalent to that of the installed ungrounded supply conductors. Table 250.102(C)(1) and Note 2

1. Problem: What size supply-side aluminum equipment bonding jumper is required for a service fed with (4) 2000 kcmil XHHW aluminum conductors?

Solution: 2000 kcmil × 12.5% = 250 kcmil — 250.102(C)(1), Table 250.102(C)(1) and Note 1

Answer: 250 kcmil aluminum

2. Problem: If, instead of (4) 2000 kcmil aluminum conductors in one raceway as in the previous problem, there were four runs of (4) 500 kcmil aluminum, what size supply-side copper equipment bonding jumper would be required for each parallel run to the main service equipment ground bar?

Solution: 500 kcmil = 2 AWG copper — 250.102(C)(2), Table 250.66 Table 250.102(C)(1) and Note 2

Answer: 2 AWG copper

B. TABLE 250.122

I. Size - Equipment Bonding Jumper on Load Side of an Overcurrent Device

The equipment bonding jumper on the load side of an overcurrent device(s) shall be sized, in accordance with 250.122. A single common continuous equipment bonding jumper shall be permitted to connect two or more raceways or cables if the bonding jumper is sized in accordance with 250.122 for the largest overcurrent device supplying circuits therein. 250.102(D)

1. Problem: What size copper equipment bonding jumper is required on the load side of a 300 amp overcurrent device?
   Solution: 300 amps = 4 AWG copper — 250.102(D), Table 250.122

   Answer: 4 AWG copper

2. Problem: What size aluminum equipment bonding jumper is required on the load side of a 125 amp overcurrent device?
   Solution: 125 amps = 4 AWG aluminum — 250.102(D), Table 250.122

   Answer: 4 AWG aluminum

3. Problem: What size copper equipment bonding jumper is required on the load side of a 5 amp overcurrent device?
   Solution: 5 amps = 14 AWG copper — 250.102(D), Table 250.122

   Answer: 14 AWG copper

II. Equipment Grounding Conductors

The size of copper, aluminum, or copper-clad aluminum equipment grounding conductors shall not be less than given in Table 250.122, but shall not be required to be larger than the circuit conductors supplying the equipment. 250.122(A)

1. Problem: What size copper equipment grounding conductor is required on the load side of a 75 amp overcurrent device?
   Solution: 75 amps = 8 AWG copper — 250.122(A), Table 250.122

   Answer: 8 AWG copper

2. Problem: What size copper equipment grounding conductor is required for a feeder protected at 100 amperes which has been increased in size from 3 AWG copper to 1/0 AWG copper to compensate for voltage drop?
   Solution:
   3 AWG = 52,620 cmils — 250.122(B), Table 8 of Ch 9
   1/0 AWG = 105,600 cmils
   105,600 ÷ 52,620 = 2.0
   8 AWG = 16,510 cmils — Table 250.122
   16,510 x 2.0 = 33,020 cmils
   33,020 cmils = 4 AWG

   Answer: 4 AWG copper

3. Problem: What size copper equipment grounding conductor is required in a raceway containing (1) 60-amp circuit, (1) 50-amp circuit, and (2) 20-amp circuits?

Solution: 60-amp circuit is the largest overcurrent device contained in the raceway. 250.122(C)

60 amps = 10 AWG copper — Table 250.122

Answer: 10 AWG copper

4. Problem: What size copper equipment grounding conductors are required for an 800-amp subpanel fed with 4 parallel runs of (4) 3/0 AWG THW copper conductors in each run?

Solution: 800 amps = 1/0 AWG copper — 250.122(F), Table 250.122

Answer: 1/0 AWG copper in **each** parallel run

Problem: What size copper equipment grounding conductor is required for a 60 amp subpanel fed with 6 AWG copper conductors tapped from a 600 amp feeder?

Solution: 600 amps = 1 AWG copper — Table 250.122
250.122 Not required to be larger than tap conductors. — 250.122 (G)

Answer: 6 AWG copper

What is the minimum size copper conductors required for the following:

1. Grounding Electrode Conductor (Metal Water Pipe or Building Steel)
2. Main Bonding Jumper
3. Equipment Bond on Supply Side of Service - Individual Bonding Jumper

for each parallel run Service fed with 1 run of (4) 250 kcmil copper conductors:

1._____AWG Cu 250.66, Table 250.66

2._____kcmil Cu 250.28(D)(1), Table 250.102(C)(1)

3._____AWG Cu 250.102(C), Table 250.102(C)(1)

Service fed with 6 parallel runs of (4) 400 kcmil copper conductors: (6 x 400 kcmil = 2,400 kcmil)

1._____AWG Cu 250.66, Table 250.66

2._____AWG Cu 250.28(D)(1), Table 250.102(C)(1)

3._____AWG Cu 250.102(C), Table 250.102(C)(1)

Service fed with 8 parallel runs of (4) 500 kcmil copper conductors: (8 x 500 kcmil = 4,000 kcmil)

1._AWG Cu 250.66, Table 250.66

2._kcmil Cu 250.28(D)(1), Table 250.102(C)(1)

3._AWG Cu 250.102(C), Table 250.102(C)(1)

Service fed with 4 parallel runs of (4) 350 kcmil copper conductors: (4 x 350 kcmil = 1,400 kcmil)

1.____AWG Cu 250.66, Table 250.66

2.____AWG Cu 250.28(D)(1), Table 250.102(C)(1)

3.____AWG Cu 250.102(C), Table 250.102(C)(1)

Service fed with 8 parallel runs of (4) 400 kcmil copper conductors: (8 x 400 kcmil = 3,200 kcmil)

1.______AWG Cu 250.66, Table 250.66

2.______kcmil Cu 250.28(D)(1), Table 250.102(C)(1)

3.______AWG Cu 250.102(C), Table 250.102(C)(1)

Table 250.66 Grounding Electrode Conductor for Alternating-Current Systems

Size of Largest Ungrounded Service-Entrance Conductor or Equivalent Area for Parallel Conductors (AWG/kcmil)		Size of Grounding Electrode Conductor AWG/kcmil	
Copper	**Aluminum or Copper-Clad Aluminum**	**Copper**	**Aluminum or Copper-Clad Aluminum**
2 or smaller	1/0 or smaller	8	6
1 or 1/0	2/0 or 3/0	6	4
2/0 or 3/0	4/0 or 250	4	2
Over 3/0 through 350	Over 250 through 500	2	1/0
Over 350 through 600	Over 500 through 900	1/0	3/0
Over 600 through 1100	Over 900 through 1750	2/0	4/0
Over 1100	Over 1750	3/0	250

Table 250.102 (C) (1) Grounded Conductor, Main Bonding Jumper, System Bonding Jumper, and Supply-Side Bonding Jumper for Alternating - Current Systems

Size of Largest Ungrounded Conductor or Equivalent Area for Parallel Conductors (AWG)/kcmil		Size of Grounded Conductor or Bonding Jumper* (AWG)/kcmil	
Copper	Aluminum or Copper-Clad Aluminum	Copper	Aluminum or Copper-Clad Aluminum
2 or smaller	1/0 or smaller	8	6
1 or 1/0	2/0 or 3/0	6	4
2/0 or 3/0	4/0 or 250	4	2
Over 3/0 through 350	Over 250 through 500	2	1/0
Over 350 through 600	Over 500 through 900	1/0	3/0
Over 600 through 1100	Over 900 through 1750	2/0	4/0
Over 1100	Over 1750	See Notes 1 and 2	

Notes:
1. If the ungrounded supply conductors are larger than 1100 kcmil copper or 1750 kcmil aluminum, the grounded conductor or bonding jumper shall have an area not less than 12 1/2 percent of the area of the largest ungrounded supply conductor or equivalent area for parallel supply conductors. The grounded conductor or bonding jumper shall not be required to be larger than the largest ungrounded conductor or set of ungrounded conductors.

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

3. If multiple sets of service-entrance conductors are used as permitted in 230.40, Exception No. 2, or if multiple sets of ungrounded supply conductors are installed for a separately derived system, the equivalent size of the largest ungrounded supply conductor(s) shall be determined by the largest sum of the areas of the corresponding conductors of each set.

4. If there are no service-entrance conductors, the supply conductor size shall be determined by the equivalent size of the largest service-entrance conductor required for the load to be served.
*For the purposes of applying this table and its notes, the term *bonding jumper* refers to main bonding jumpers, system bonding jumpers, and supply-side bonding jumpers.

SECTION
3

Wiring Methods 8 Hours

The course curriculum covers NEC2020 Overview, Article 100 Definitions, Conductor Ampacity and Derating, Sizing Overcurrent Devices and Conductors, Conduit and Tubing Fill, Wireways, Sizing Junction Boxes, and Sizing Pull Boxes.

Following are sample pages of material covered in the classroom and online.

Article 626	Electrified Truck Parking Spaces
Article 630	Electric Welders
Article 640	Audio Signal Processing, amplification, and Reproduction Equipment
Article 645	Information Technology Equipment

Article 646	Modular Data Centers
Article 647	Sensitive Electronic Equipment
Article 650	Pipe Organs
Article 660	X-Ray Equipment
Article 665	Induction and Dielectric Heating Equipment
Article 668	Electrolytic Cells
Article 669	Electroplating
Article 670	Industrial Machinery
Article 675	Electrically Driven or Controlled Irrigation Machines
**Article 680*	Swimming Pools, Fountains, and Similar Installations**
Article 682	Natural and Artificially Made Bodies of Water
Article 685	Integrated Electrical Systems
Article 690	Solar Photovoltaic (PV) Systems
Article 691	Large-Scale Photovoltaic (PV) Electric Supply Stations
Article 692	Fuel Cell Systems
Article 694	Wind Electric Systems
Article 695	Fire Pumps

**Chapter 7	SPECIAL CONDITIONS**
Article 700	Emergency Systems
Article 701	Legally Required Standby Systems
Article 702	Optional Standby Systems
Article 705	Interconnected Electric Power Production Sources
Article 706	Energy Storage Systems
Article 708	Critical Operations Power Systems (COPS)
Article 710	Stand Alone Systems
Article 712	Direct Connect Microgrids
Article 720	Circuits and Equipment Operating at Less than 50 Volts
Article 725	Class 1, Class 2, and Class 3 Remote-Control, Signaling, and Power-Limited Circuits
Article 727	Instrumentation Tray Cable: Type ITC
Article 728	Fire-Resistive Cable Systems
Article 750	Energy Management Systems
Article 760	Fire Alarm Systems
Article 770	Optical Fiber Cables

CHAPTER 8 IS NOT SUBJECT TO THE REQUIREMENTS OF CHAPTERS 1 – 7, EXCEPT WHERE REQUIREMENTS ARE SPECIFICALLY REFERENCED IN CHAPTER 8.

**Chapter 8	COMMUNICATIONS SYSTEMS**
Article 800	General Requirements for Communications Systems
Article 805	Communication Circuits
Article 810	Radio and Television Equipment
Article 820	Community Antenna Television and Radio Distribution Systems
Article 830	Network-Powered Broadband Communications Systems
Article 840	Premises-Powered Broadband Communications Systems

*** READ THIS ARTICLE IN ITS ENTIRETY.**

Conversion Reference Table

U.S. Customary Unit	2017 NEC SI Unit	Equivalent U.S. Unit
¼ in.	6 mm	0.24 in.
½ in.	13 mm	0.51 in.
¾ in.	19 mm	0.75 in.
1 in.	25 mm	0.98 in.
1¼ in.	32 mm	1.26 in.
1½ in.	38 mm	1.50 in.
2 in.	50 mm	1.97 in.
2½ in.	65 mm	2.56 in.
3 in.	75 mm	2.95 in.
4 in.	100 mm	3.94 in.
6 in.	150 mm	5.91 in.
12 in.	300 mm	11.81 in.
18 in.	450 mm	17.72 in.
24 in.	600 mm	23.62 in.
30 in.	750 mm	29.53 in.
36 in.	900 mm	35.73 in.
4 ft 6 in.	1.4 m	4.59 ft
5 ft	1.5 m	4.92 ft
6 ft	1.8 m	5.91 ft
6 ft 6 in.	2.0 m	6.56 ft
6 ft 7 in.	2.0 m	6.56 ft
7 ft 6 in.	2.3 m	7.55 ft
8 ft	2.5 m	8.20 ft
10 ft	3.0 m	9.84 ft
12 ft	3.7 m	2.14 ft
15 ft	4.5 m	15.09 ft
18 ft	5.5 m	18.05 ft
20 ft	6.0 m	19.69 ft
25 ft	7.5 m	24.61 ft
30 ft	9.0 m	29.53 ft
50 ft	15 m	49.22 ft

Metric Designator and Trade Sizes

Table 300.1(C)

Metric Designator	**Trade Sizes**
12	3/8
16	½
21	¾
27	1
35	1¼
41	1½
53	2
63	2½
78	3
91	3½
103	4
129	5
155	6

Article 100 Definitions

Ampacity
The maximum current, in amperes, that a conductor can carry continuously under the conditions of use without exceeding its temperature rating. (CMP-6)

Bathroom
An area including a sink (basin) with one or more of the following: a toilet, a urinal, a tub, a shower, a bidet, or similar plumbing fixtures. (CMP-2)

Bonding Jumper, Main
The connection between the grounded circuit conductor and the equipment grounding conductor, or the supply-side bonding jumper, or both, at the service. (CMP-5)

Bonding Jumper, System
The connection between the grounded circuit conductor and the supply-side bonding jumper, or the equipment grounding conductor, or both, at a separately derived system. (CMP-5)

Branch Circuit
The circuit conductors between the final overcurrent device protecting the circuit and the outlet(s). (CMP-2)

Branch Circuit, General Purpose
A branch circuit that supplies two or more receptacles or outlets for lighting and appliances. (See 210.3 for standard ratings.) (CMP-2)

Branch Circuit, Individual
A branch circuit that supplies only one utilization equipment. (See 240.6 for standard ratings.) (CMP-2)

Branch Circuit, Multiwire
A branch circuit that consists of two or more ungrounded conductors that have a voltage between them, and a grounded conductor that has equal voltage between it and each ungrounded conductor of the circuit and that is connected to the neutral or grounded conductor of the system. (CMP-2)

Continuous Load
A load where the maximum current is expected to continue for three hours or more. (CMP-2)

Feeder
All circuit conductors between the service equipment, the source of a separately derived system, or other power supply source, and the final branch circuit overcurrent device. (CMP-10)

In Sight From (Within Sight From, Within Sight)
Where this *Code* specifies that one equipment shall be “in sight from,” “within sight from,” or “within sight of,” and so forth, another equipment, the specified equipment is to be visible and not more than 15 m (50 ft) distant from the other. (CMP-1)

	Question	Answer	Reference
	NFPA 70 – 2017 Edition-Page 30		
1.	Revisions to the 2020 NEC are highlighted with ____________ _________ within sections and with a N for new material.	shaded text	Footer of all pages in the NEC® 2020
	Article 90 - Introduction		
1.	The purpose of the National Electrical Code is the practical safeguarding of persons and property from hazards arising from the use of ____________.	electricity	90.1(A)
2.	Is the NEC intended to be an instruction manual for untrained persons?	No	90.1(A)
3.	Are electrical installations in ships or watercraft, other than floating buildings, covered in the NEC?	No	90.2(B)(1)
4.	The authority having jurisdiction for enforcement of the NEC will have the responsibility for making interpretations of the rules for deciding upon the approval of ____________ and ____________ and for granting the special permission contemplated in a number of the rules.	equipment and materials	90.4
5.	By special permission, the ________________ ___________ ________________ may waive specific requirements in the National Electrical Code or permit alternative methods where it is assured that equivalent objectives can be achieved by establishing and maintaining effective safety.	authority having jurisdiction	90.4
	Article 100 - Definitions		
1.	The maximum current in amps that a conductor can carry continuously under the conditions of use without exceeding its temperature ratings is its ____________.	ampacity	Article 100-Definitions
2.	Which type of optical fiber cable contains optical fibers and current-carrying electrical conductors?	composite cable	Article 100 - Definitions
3.	Nonconductive optical fiber cable is a factory assembly of one or more optical fibers having an overall covering and containing no ____________ ____________ materials.	Electrically conductive	Article 100 - Definitions

	Question	Answer	Reference
4.	The ___________ bonding jumper is the connection between the grounded circuit conductor and the equipment grounding conductor, or the supply-side bonding jumper, or both, at the service.	main	Article 100 - Definitions
5.	A continuous load is one in which the maximum current is expected to continue for ____ hours or more.	3 hours	Article 100 - Definitions
6.	A system or circuit conductor that is intentionally grounded is the _________ conductor.	grounded	Article 100 - Definitions
7.	In Article 430, the term "in sight from" is also speaking of a distance not more than ____ feet.	50 feet	Article 100 - Definitions
8.	Conduit encased in concrete in direct contact with the earth shall be considered a ______ location.	wet location	Article 100 – Definitions, 300.5(B)
9.	Operation of equipment in excess of normal, full-load rating is called an ______________.	overload	Article 100 - Definitions
10.	The conductors from the service point to the service disconnecting means are called ____________ conductors.	service conductors	Article 100 - Definitions
11.	The point of connection between the facilities of the serving utility and the premises wiring is called the ______ ______.	service point	Article 100 - Definitions
12.	The greatest root-mean-square (rms)(effective) difference of potential between any two conductors of the circuit is the __________ of a circuit.	voltage	Article 100 - Definitions

Article 110 - Requirements for Electrical Installations

	Question	Answer	Reference
1.	The conductors and equipment required or permitted by this Code shall be acceptable only if ____________________.	approved	110.2
2.	Where the conductor material is not specified, the material and the sizes given in the NEC shall apply to __________ conductors.	copper	110.5
3.	Electrical equipment shall be installed in a neat and ______________ manner.	workmanlike	110.12
4.	Unused openings in boxes, raceways, auxiliary gutters, cabinets, equipment cases, or housings shall be effectively _________ to afford protection substantially equivalent to the wall of the equipment.	closed	110.12(A)

	Question	Answer	Reference
5.	Electric equipment shall be firmly secured to the surface on which it is mounted, ________ plugs driven into holes in masonry, concrete, plaster, or similar materials shall not be used.	wooden	110.13(A)
6.	Connection to terminals by means of wire binding screws or studs and nuts having upturned lugs or equivalent shall be permitted for ______ AWG or smaller conductors.	10 AWG	110.14(A)
7.	Terminals for more than one conductor and terminals used to connect aluminum shall be so ______________.	identified	110.14 (A)
8.	The high-leg of a 4-wire, delta-connected service shall be identified by an outer finish that is ________ in color or by tagging or other effective means.	orange	110.15, 230.56
9.	Each disconnecting means shall be ___________ marked to indicate its purpose unless located and arranged so the purpose is evident.	legibly	110.22(A)
10.	Equipment enclosures for circuit breakers or fuses applied in compliance with the series combination ratings marked on the equipment by the manufacturer in accordance with 240.86 (B) shall be legibly marked in the field to indicate the equipment has been applied with a series combination rating. The marking shall meet the requirements in 110.21(B) and shall be readily visible and state the following: CAUTION - _____________ _____________ ___________ RATED. IDENTIFIED REPLACEMENT COMPONENTS REQUIRED.	SERIES COMBINATION SYSTEM	110.22(C)
11.	Service equipment in other than dwelling units shall be legibly marked in the field with the maximum available ______ ________ and the date the calculation was performed.	fault current	110.24(A)
12.	The depth of a working space of a 120/240-volt panelboard in a Condition 1 is _______ feet.	3 feet	110.26 (A)(1), Table 110.26 (A)(1)
13.	Where rear access is required to work on nonelectrical parts on the back of enclosed electrical equipment, a minimum horizontal working space of _____ inches shall be provided.	30 inches	110.26 (A)(1)(a)

	Question	Answer	Reference
14.	The width of the working space in front of the electric equipment shall be the width of the equipment or ______ inches, whichever is greater.	30 inches	110.26(A)(2)
15.	The minimum headroom of working space above motor control centers shall be _____ feet.	6 ½ feet	110.26(A)(3)
16.	Where a motor control center exceeds ______ feet in height, the minimum headroom shall not be less than the height of the equipment.	6 ½ feet	110.26(A)(3)
17.	Other equipment associated with the electrical installation located above or below the electrical equipment shall be permitted to extend not more than ______ inches beyond the front of the electrical equipment.	6 inches	110.26(A)(3)
18.	The minimum headroom of working space above a 100-amp panelboards that do not exceed 200 amperes and are located in an existing dwelling unit is ______ feet.	No requirement	110.26(A)(3) Ex. 2
19.	For large equipment that contains overcurrent devices, switching devices, or control devices rated 1200 amperes or more, and over 6 feet wide, there shall be one entrance to and egress from the required working space not less than 24 inches wide and ________ feet high at each end of the working space.	6 ½ feet	110.26(C)(2)
20.	Where equipment rated _______ amperes or more that contains overcurrent devices, switching devices or control devices is installed and there is a personnel door(s) intended for entrance to and egress from the working space less than 7.6 m (25 ft) from the nearest edge of the working space, the door(s) shall open in the direction of egress and be equipped with listed panic hardware.	800 amps	110.26(C)(3)
21.	The space equal to the width and depth of an indoor panelboard and extending from the floor to a height of ____ feet above the equipment or to the structural ceiling, whichever is lower, shall be dedicated to the electrical installation.	6 feet	110.26(E)(1)(a)
22.	Enclosures housing electrical apparatus that are controlled by a _______ shall be considered accessible to qualified persons.	lock	110.26(F)
23.	Unless specified otherwise, live parts of electrical equipment operating at 50 to _____ volts shall be guarded.	1000 volts	110.27(A)

	Question	Answer	Reference
24.	What is the enclosure type number for an indoor motor controller that is occasionally submerged for prolonged periods?	6P	110.28, Table 110.28
25.	At what voltage must electrical equipment installed outdoors be protected by a wall, screen or fence to deter access by persons who are not qualified?	over 1000 volts	110.30, 110.31
26.	An outdoor electrical substation operating at over 600 volts shall be protected by a fence that shall not be less than ______ feet in height.	7 feet	110.31
27.	Where rear access is required to work on nonelectrical parts on the back of enclosed equipment rated over 1000 volts, a minimum working space of _____ inches shall be provided.	30 inches	110.34(A) Ex.
28.	The entrances to all buildings, rooms, or enclosures containing exposed live parts or exposed conductors operating at over _____ volts, nominal, shall be kept locked, unless such entrances are under the observation of a qualified person at all times.	1000 volts	110.34(C)
29.	Unguarded live electrical parts operating at 34,500 volts shall have a minimum height of ____ feet above a working space.	9 ½ feet	110.34(E), Table 110.34 (E)
30.	In over 1000-volt installations, conductors shall be permitted to be terminated based on the ______°C temperature rating and ampacity as given in Tables 311.60(C)(67) through 311.60(C)(86), unless otherwise identified.	90°C	110.40

Article 200 – Use and Identification of Grounded Conductors

1.	An insulated grounded conductor of ______ AWG or smaller shall be identified by a continuous white or natural gray outer finish or by three continuous white or gray stripes on other than green insulation along its entire length.	6 AWG	200.6(A)
2.	An insulated grounded conductor ______ AWG or larger shall be identified either by a continuous white or natural gray outer finish along its entire length, by three continuous white or gray stripes along the conductor's entire length on other than green insulation, or at the time of installation by a distinctive white or gray marking at its terminations.	4 AWG	200.6(B)

	Question	Answer	Reference
3.	Where grounded conductors of different systems are installed in the same raceway, cable, box, auxiliary gutter or other type of enclosure, each other system- grounded conductor shall have an outer covering of _________ or gray, with a readily distinguishable different colored stripe (not green) running along the insulation.	white	200.6(D)(2)
4.	A continuous white or natural gray covering, three continuous white or gray stripes on other than green insulation, or a termination marking of white or natural gray color shall be used only for the _________ conductor.	grounded	200.7 (A)(1)(2)(3)
5.	Where a cable contains an insulated conductor for single pole, 3-way, or 4-way switch loops, the conductor with white insulation shall be __________ re-identified to indicate its use by marking tape, painting, or other effective means at its terminations and at each location where the conductor is visible and accessible.	permanently	200.7(C)(1)
6.	In general, the identification of terminals to which a grounded conductor is to be connected shall be substantially _________ in color.	white	200.9
7.	For devices with screw shells, the terminal for the ___________ conductor shall be the one connected to the screw shell.	grounded	200.10(C)

Article 210 - Branch Circuits

	Question	Answer	Reference
1.	Each multiwire branch circuit shall be provided with a ________ that will simultaneously disconnect all ungrounded conductors at the point where the branch circuit originates.	means	210.4(B)
2.	Where the premises wiring system has branch circuits supplied from more than one nominal voltage system, each ungrounded conductor of a branch circuit shall be identified by_________ or ________ and system at all termination, connection and splice points in compliance with 210.5(C)(1)(a) and (b).	phase, line	210.5(C)(1)
3.	In dwelling units, the voltage shall not exceed ______ volts, nominal, between conductors that supply the terminals of luminaires.	120 volts	210.6(A)(1)

	Question	Answer	Reference
4.	Is a 1200-watt, 240-volt heater on a cord plug-in legal in a dwelling unit?	No, the load must be greater than 1440 watts for voltages higher than 120.	210.6(A)(2)
5.	Circuits exceeding 120 volts, nominal, between conductors and not exceeding ______ volts, nominal, to ground, shall be permitted to supply listed electric-discharge or listed light-emitting diode-type luminaires.	277 volts	210.6(C)(1)
6.	The maximum voltage permitted for ungrounded circuits supplying pole-mounted ballasts for lighting units installed above 22 feet is _____ volts.	600 volts	210.6(D)(1) a
7.	The ground-fault circuit-interrupter shall be installed in a ________ __________ location.	readily accessible	210.8
8.	All 125-volt through 250-volt receptacles installed in dwelling unit garages, and also accessory buildings that have a floor located at or below grade level not intended as habitable rooms and limited to storage areas, work areas, and areas of similar use, shall have __________-___________ __________-_____________	ground-fault circuit-interrupter	210.8(A)(2)
9.	All 125-volt through 250-volt, receptacles installed outdoors of dwelling units shall have __________-__________ ____________-____________ protection for personnel.	ground-fault circuit-interrupter	210.8(A)(3)
10.	All 125-volt, through 250-volt receptacles located in areas other than kitchens where receptacles are installed within ______ feet from the top inside edge of the bowl of the sink shall be GFCI protected.	6 feet	210.8(A)(7)
11.	Receptacles installed within ___ feet of a dwelling kitchen sink shall be GFCI and AFCI protected.	6 feet	210.8(A)(7) 210.12(A)
12.	All 125-volt, single-phase, 15- and 20-ampere receptacles installed in dwelling unit laundry areas shall be _____ and _____ protected.	GFCI and AFCI	210.8(A)(10) 210.12(A)
13.	In other than dwelling units, all 150-volt to ground or less, single-phase, 50-ampere or less receptacles installed in bathrooms, kitchens, _______________, outdoors, sinks, indoor wet locations, locker rooms, garages, crawl spaces and unfinished basements shall have ground-fault circuit-interrupter protection for personnel.	rooftops	210.8 (B)(1)(2)(3)(4)(5)(6)(7)(8)(9)(10)

	Question	Answer	Reference
14.	All 125-volt, through 250-volt receptacles installed in locker rooms with associated showering facilities in other than dwelling units shall have ______ protection.	GFCI	210.8(B)(9)
15.	In general, branch circuits shall not be derived from autotransformers unless the circuit supplied has a _________ conductor that is electrically connected to a grounded conductor of the system supplying the autotransformer.	grounded	210.9
16.	Where the required _______-ampere circuit supplies a single bathroom in a dwelling unit, outlets for other equipment within the same bathroom shall be permitted to be supplied in accordance with Section 210.23 (A)(1) and (A)(2).	20-ampere	210.11(C)(3) Ex.
17.	In addition to the number of branch circuits required by other parts of this section, at least one 120-volt____ -ampere branch circuit shall be installed to supply receptacle outlets in attached garages and in detached garages with electric power. This circuit shall have no other outlets.	20-ampere	210.11 (C)(4)
18.	The arc-fault circuit interrupter shall be installed in a __________ __________ location.	readily accessible	210.12
19.	All branch circuits that supply 125-volt, single-phase, 15- and 20-ampere outlets or devices installed in dwelling unit kitchens, family rooms, dining rooms, living rooms, parlors, libraries, dens, bedrooms, sunrooms, recreation rooms, closets, hallways, laundry areas, or similar rooms or areas shall be protected by an ________ _________ __________ utilizing any of the means described in 210.12 (A)(1) through (6).	arc-fault circuit interrupter	210.12(A)
20.	_____________ circuits recognized by the NEC shall be rated in accordance with the maximum permitted ampere rating or setting of the overcurrent device and be sized for 15, 20, 30, 40, and 50 amperes for other than individual branch circuits.	Branch circuits	210.18
21.	The recommended maximum total voltage drop for feeders and branch circuits combined should not exceed _____%.	5%	210.19(A) Info Nt No. 3

	Question	Answer	Reference
22.	Where a branch circuit supplies continuous loads or any combination of continuous and noncontinuous loads, the minimum branch-circuit conductor size, shall have an allowable ampacity not less than the noncontinuous load plus ______ % of the continuous load.	125%	210.19(A)(1)(a)
23.	The minimum branch circuit rating to a single electric range of over 8¾ kW shall be ______ amps.	40 amps	210.19(A)(3)
24.	Tap conductors supplying electric ranges, wall-mounted electric ovens, and counter-mounted electric cooking units from a 50-ampere branch circuit shall have an ampacity of not less than _______ amps and shall be sufficient for the load to be served.	20 amps	210.19(A)(3) Ex. 1
25.	The smallest conductor allowed for the grounded conductor of existing branch circuits supplying household electric ranges is _______ AWG.	10 AWG	210.19(A)(3) Ex. 2
26.	A 20-amp tap conductor from a 40-amp circuit feeding an individual lampholder shall not exceed ______ inches in length.	18 inches	210.19(A)(4) Ex. 1(1)
27.	A heavy-duty lampholder of the admedium type shall have a rating of not less than ____ watts.	660 watts	210.21(A)
28.	A single receptacle installed on an individual branch circuit shall have a rating of not less than _____ percent of the rating of the branch circuit.	100%	210.21(B)(1)
29.	The maximum load of a cord-and-plug connected appliance used on a 20-amp branch circuit having two or more outlets shall not exceed _____ amps.	16 amps	210.21(B)(2), Table 210.21(B)(2)
30.	Receptacles connected to a 30-amp branch circuit supplying two or more outlets shall be rated not less than ____ amps.	30 amps	210.21(B)(3), Table 210.21(B)(3)
31.	When several portable appliances are used in 15- or 20-amp branch circuits, the rating of any one cord-and-plug connected utilization equipment shall not exceed ____% of the branch circuit.	80%	210.23(A)(1)
32.	The total rating of utilization equipment fastened in place shall not exceed ____% of a 15- or 20-ampere branch-circuit amp rating where lighting units, cord- and plug-connected utilization equipment not fastened in place, or both, are also supplied.	50%	210.23(A)(2)

	Question	Answer	Reference
33.	The rating of any one cord and plug connected appliance used on a 30-amp branch circuit shall not exceed ______ % of the branch-circuit ampere rating.	80%	210.23(B)
34.	Branch circuits larger than _____ amperes shall supply only non-lighting outlet loads.	50 amperes	210.23(D)
35.	Where two or more receptacles are used on 20-amp circuits they shall be rated not less than ______ amps.	15 amps	210.24 Table 210.24
36.	Appliance receptacle outlets installed in a dwelling unit for specific appliances, such as laundry equipment shall be installed within _____ feet of the intended location of the appliance.	6 feet	210.50(C)
37.	Dwelling unit receptacle outlets _____ feet above the floor are not counted in the required number of receptacles along the wall.	5 ½ feet	210.52(4)
38.	In a dwelling unit, receptacles shall be installed such that no point measured horizontally along the floor line of any wall space, is more than _____ feet from a receptacle outlet.	6 feet	210.52(A)(1)
39.	Receptacles shall be installed in any wall space ___ feet or more in width including space measured around corners and unbroken along the floor line by doorways and similar openings, fireplaces, and fixed cabinets in dwelling units.	2 feet	210.52(A)(2) (1)
40.	Receptacle outlets in floors of dwelling units shall not be counted as part of the required number of receptacle outlets unless located within ____ inches of the wall.	18 inches	210.52(A)(3)
41.	Countertop receptacle outlets installed in the kitchen shall be supplied by not less than ____ small appliance branch circuits.	two	210.52(B)(1)
42.	Is a refrigerator allowed to be installed on a small appliance branch circuit?	Yes	210.52(B)(1)
43.	Is a receptacle installed solely for the electrical supply to and support of an electric clock allowed on the required two or more small appliance branch circuits?	Yes	210.52(B)(2) Ex. 1
44.	In kitchen and dining areas, a receptacle outlet shall be installed at each wall countertop and work surface that is _____ inches or wider.	12 inches	210.52(C)

	Question	Answer	Reference
45.	Receptacle outlets above dwelling unit countertops shall be installed so that no point along the wall line is more than _____ inches measured horizontally from a receptacle outlet in that space.	24 inches	210.52(C)(1)
46.	At least one receptacle outlet shall be provided for the first ______ ft^2 or fraction thereof of an island countertop space, located in a dwelling unit.	9 ft^2	210.52(C)(2)(a)
47.	At least one receptacle outlet shall be located within __ feet of the outer end of a peninsular countertop or workspace.	2 feet	210.52(C)(2)(b)
48.	In kitchens and dining rooms of dwelling units, receptacle outlets shall be located on or above, the countertop, or work surfaces but not more than ____ inches above the countertop or work surface.	20 inches	210.52(C)(3)(1)
49.	In dwelling units, at least one wall receptacle outlet shall be installed in bathrooms within ______ feet of the outside edge of each basin.	3 feet	210.52(D)
50.	For a one-family dwelling and each unit of a two-family dwelling that is at grade level, at least one receptacle outlet accessible at grade level and not more than ______ feet above grade shall be installed at the front and back of the dwelling.	6 ½ feet	210.52(E)(1)
51.	In dwelling units, at least _____ receptacle outlet shall be installed in areas designated for the installation of laundry equipment.	one	210.52(F)
52.	In one- and two-family dwellings at least one receptacle outlet shall be installed in each vehicle bay of attached garages and detached garages with electric power at not more than ____ feet above the floor.	5 ½ feet	210.52(G)(1)
53.	In dwelling units, hallways of _____ feet or more in length shall have at least one receptacle outlet.	10 feet	210.52(H)
54.	In guest rooms of hotels and motels , at least ______ receptacles shall be readily accessible.	two	210.60(B)
55.	The space measured horizontally above a show window must have at least one 125-volt, single-phase, 15- or 20-ampere rated receptacle for each _____ linear feet or major fraction thereof.	12 linear feet	210.62

	Question	Answer	Reference
56.	A 125-volt, single-phase, 15- or 20-ampere rated receptacle outlet shall be installed at an accessible location located on the same level within _____ feet of rooftop HVAC equipment.	25 feet	210.63 (A)
57.	In other than one- and two-family dwellings at least one 125-volt, single-phase, 15- or 20-ampere-rated receptacle outlet shall be installed within ___ feet and within the same room or area as the electrical service equipment.	25 feet	210.63(B)(1)
58.	Is a light fixture required in a clothes closet in a dwelling unit?	No	210.70(A)(1)
59.	In other than __________ and __________, one or more receptacles controlled by a wall switch shall be permitted in lieu of lighting outlets in dwelling units.	kitchens bathrooms	210.70(A)(1) Ex. 1
60.	Is a vehicle door in an attached garage considered an outdoor entrance?	No	210.70 (A)(2)(2)
61.	Where one or more lighting outlet(s) are installed for interior stairways, there shall be a wall switch at each floor level, and landing level that includes an entry way, to control the lighting outlet(s) where the stairway between floor levels has ______ risers or more.	six	210.70 (A)(2)(3)

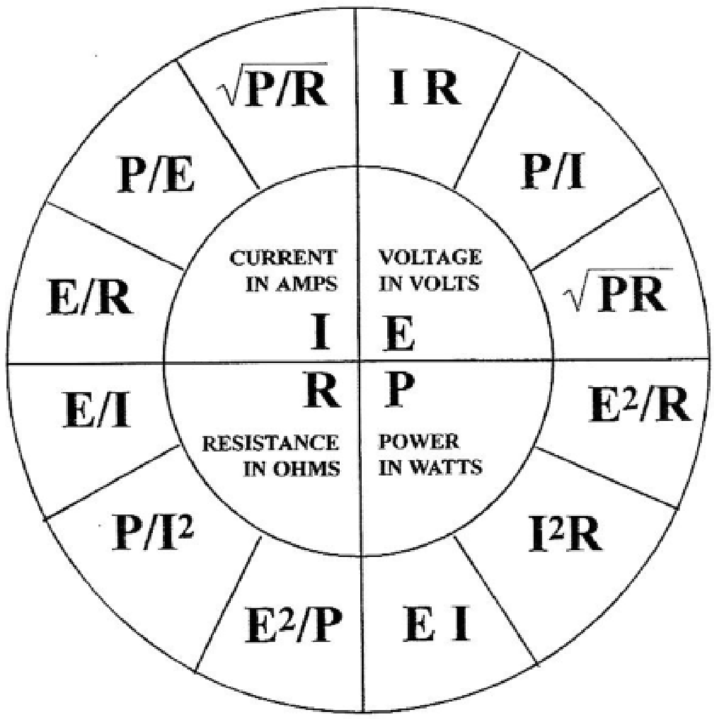
SECTION 4

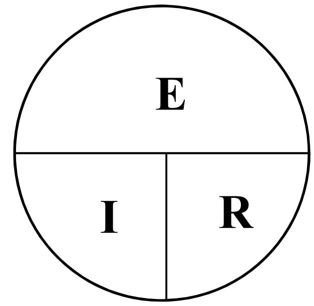
Theory and Calculations 8 Hours

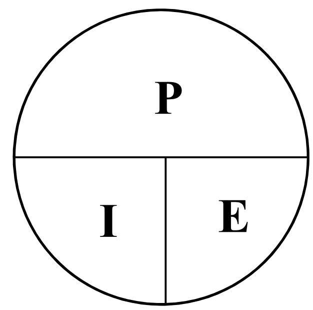
The course curriculum covers Ohm's Law and voltage drop, general lighting and receptacle calculations, range and dryer calculations, fixed appliance calculations, sizing grounding conductors, motor calculations, generator calculations, welder calculations, transformer formulas and calculations, miscellaneous commercial calculations, and service calculations for residential and commercial installations.

Following are sample pages of material covered in the classroom and online.

Formulas







Opposition to current in a dc circuit is resistance (R)
Opposition to current in an ac circuit is impedance (Z) and is made up of 3 components:

1. R Resistance
2. X_L Inductive reactance
3. X_c Capacitive reactance

IMPEDANCE FORMULA

$$Z = \sqrt{R^2 + (X_L - X_C)^2}$$

VOLTAGES:

Unless other voltages are specified for purposes of computing branch circuit and feeder loads, nominal system voltages of 120, 120/240, 208Y/120, 240, 347, 480Y/277, 480, 600Y/347, and 600 volts shall be used. (220.5(A), Informative Annex D)

CALCULATED LOAD:

For reasonable precision, volt-ampere calculations are carried to three significant figures only; where loads are converted to amperes the results are rounded to the nearest ampere [see 220.5(B)].
Informative Annex D Example D3 (a) Calculated Load

FRACTIONS OF AN AMPERE:

Calculations shall be permitted to be rounded to the nearest whole ampere, with decimal fractions smaller than 0.5 dropped. (220.5(B), Informative Annex D)

- $\text{Current Single - Phase AC} = \dfrac{\text{Watts}}{\text{E}} \text{ or } \dfrac{\text{VA}}{\text{E}}$

- $\text{Current Three - Phase AC} = \dfrac{\text{Watts}}{\text{E} \times \sqrt{3}} \text{ or } \dfrac{\text{VA}}{\text{E} \times \sqrt{3}}$

$$\begin{aligned}
&\text{208 Volt Three - Phase} \times \sqrt{3} = 360 \\
&\text{230 Volt Three - Phase} \times \sqrt{3} = 398 \\
&\text{240 Volt Three - Phase} \times \sqrt{3} = 416 \\
&\text{440 Volt Three - Phase} \times \sqrt{3} = 762 \\
&\text{460 Volt Three - Phase} \times \sqrt{3} = 797 \\
&\text{480 Volt Three - Phase} \times \sqrt{3} = 831
\end{aligned}$$

- Current on Single-Phase Neutral = Unbalance of Load Between Ungrounded Conductors
  Example: Phase A = 100 Amps, Phase B = 75 Amps, Neutral = 25 Amps

Voltage Drop

► The two steps in determining voltage drop are:

1. Determining volts loss
2. Determining percent voltage drop

NOTE: The maximum recommended voltage drop by the NEC is 5% total for feeder and branch circuit, with neither feeder nor branch circuit exceeding 3% [see 210.19(A)(1) Informational Note No. 3 and 215.2(A)(1)(b) Informational Note No. 2.

► A formula for single-phase volts loss is: $\frac{2 \text{ x Resistivity Factor x Amps x Length}}{\text{Circular Mils}}$

(Table 8, Chapter 9)

Problem: What is the volt loss for a 120-volt circuit feeding a 10-amp load 200 feet away supplied by 10 AWG THHN copper conductors? (Resistivity Factor 12.9)

Solution: $\frac{2 \times 12.9 \times 10 \times 200}{10{,}380} = \frac{51{,}600}{10{,}380} = 4.97 \text{volts}$ (Table 8, Chapter 9)

Answer: 5 volts

► The formula for percent voltage drop is:

$$\frac{\text{Volts Loss}}{\text{Applied Voltage}}$$

Problem: What is the percent voltage drop for 3.8 volts loss on a 120-volt circuit?

Solution: $\frac{3.8}{120} = 0.0316$

Answer: 3.2%

► Another formula for single-phase volts loss is: $\frac{2 \text{ x Resistivity (Ohms/kFT) Amps x Length}}{1{,}000}$

Problem: What is the volt loss for a single-phase, 240-volt circuit feeding a 30-amp load 250 feet away supplied by 10 AWG THHN stranded copper conductors?

Solution: $\frac{2 \text{ x } 1.24 \text{ x } 30 \text{ x } 250}{1{,}000} = \frac{18{,}600}{1{,}000} = 18.6 \text{ Volts}$ (Table 8, Chapter 9)

Answer: 18.6 volts

► A formula for three-phase volts loss is: $\frac{\sqrt{3} \text{ x Resistivity Factor x Amps x Length}}{\text{Circular Mils}}$

Problem: What is the volt loss for a three-phase, 208-volt circuit feeding a 35-amp load 175 feet away supplied by 8 AWG THHN copper conductors? (Resistivity Factor 12.9)

Solution: $\dfrac{\sqrt{3} \text{ x } 12.9 \text{ x } 35 \text{ x } 175}{16{,}510} = \dfrac{136{,}849.65}{16{,}510} = 8.29 \text{ volts}$ (Table 8, Chapter 9)

Answer: 8.3 volts

► Another formula for three-phase volts loss is: $\dfrac{\sqrt{3} \text{ x Resistivity (Ohms/kFT) x Amps x Length}}{1{,}000}$

Problem: What is the volts loss for a three-phase, 480-volt circuit feeding a 50-amp load 150 feet away supplied by 6 AWG THW stranded copper conductors?

Solution: $\dfrac{\sqrt{3} \text{x } .491 \text{ x } 50 \text{ x } 150}{1{,}000} = \dfrac{6{,}378.09}{1{,}000}$ 6.38 Volts

Answer: 6.4 volts

► The formula for wire size in circular mils single-phase is:

$$\frac{\text{2 x Resistivity Factor x Amps x Length}}{\text{Volts Loss}}$$

Problem: What size THHN copper conductors are required for a 3% voltage drop for a 120-volt circuit feeding a 10-amp load 200 feet away? (Resistivity Factor 12.9)

Solution: $\dfrac{2 \text{ x } 12.9 \text{ x } 10 \text{ x } 200}{3.6 \text{ (3\% of 120 volt)}} = \dfrac{51{,}600}{3.6} = 14{,}333.3$

14,333.3 circular mils = 8 AWG THHN copper (Table 8 of Chapter 9)

Answer: 8 AWG THHN copper

► The formula for determining the distance a particular wire size will carry a specific single-phase load is:

$$\frac{\text{Volt Loss x Circular Mils}}{\text{2 x Resistivity Factor x Amps}}$$

Problem: What is the maximum distance 12 AWG THHN copper conductors will carry a 12-amp, 120-volt load not exceeding a 3% voltage drop? (Resistivity Factor 12.9)

Solution: $\dfrac{3.6 \text{ (3\% of 120)x } 6{,}530}{2 \text{ x } 12.9 \text{ x } 12} = \dfrac{23{,}508}{309.6} = 75.9 \text{ feet}$

Answer: 75.9 feet

Sizing Overcurrent Devices and Conductors

240.6 Standard Ampere Ratings

(A) Fuses and Fixed-Trip Circuit Breakers. The standard ampere ratings for fuses and inverse time circuit breakers shall be considered as shown in Table 240.6(A). Additional standard ampere ratings for fuses shall be 1, 3, 6, 10, and 601 The use of fuses and inverse time circuit breakers with nonstandard ampere ratings shall be permitted.

Note: **Individual** branch circuit ratings include 25, 35, and 45 amperes.

Table 240.6(A) Standard Ampere Ratings for Fuses and Inverse Time Circuit Breakers

Standard Ampere Ratings				
15	20	25	30	35
40	45	50	60	70
80	90	100	110	125
150	175	200	225	250
300	350	400	450	500
600	700	800	1000	1200
1600	2000	2500	3000	4000
5000	6000	----	----	----

210.18 Rating

Branch circuits recognized by this article shall be rated in accordance with the maximum permitted ampere rating or setting of the overcurrent device. The rating for **other than individual** branch circuits shall be 15, 20, 30, 40, and 50 amperes. Where conductors of higher ampacity are used for any reason, the ampere rating or setting of the specified over-current device shall determine the circuit rating.

SIZING OVERCURRENT DEVICES RATED 800 AMPERES OR LESS 240.4(B)

Step 1. Size the conductors to the load. 210.19(A)(1), 215.2(A)(1)(a)

Step 2. Protect the conductors with the next standard overcurrent device rating above the rating of the load. 240.4(B), 240.6(A) Table 240.6(A)

Note: 25, 35, and 45 ampere ratings only apply to individual branch circuits. 210.18, 240.6(A), Table 240.6(A)

SIZING OVERCURRENT DEVICES RATED OVER 800 AMPERES 240.4(C)

Step 1. Go to the next standard overcurrent device rating from Table 240.6(A) above the rating of the load.
Step 2. Size the ampacity of the conductors to be equal to or greater than the rating of the overcurrent device. 240.4(C)

Box Sizing

To determine conductor fill for junction boxes:

A. For conductors which are the same size, use Table 314.16 (A).

B. For conductors which are not the same size:

1) Determine total volume of conductors in cubic inches from Table 314.16(B).

2) Determine box capacity from Table 314.16 (A).

1. Problem: How many 14 AWG conductors are allowed in a 4" × 1½" octagonal box?

Solution: Table 314.16(A)

Answer: 7

2. Problem: How many 12 AWG conductors are allowed in a 4 11/16" × 1½" square box?

Solution: Table 314.16(A)

Answer: 13

3. Problem: How deep of a standard size 4 inch square box is required to contain (4) 12 AWG conductors, (3) 10 AWG conductors, and (2) 8 AWG conductors?

Solution:

$4 \times 2.25\ in^3 =$	$9.0\ in^3$	Table 314.16 (B)
$3 \times 2.5\ in^3 =$	$7.5\ in^3$	
$2 \times 3\ in^3 =$	$6.0\ in^3$	
Total	$22.5\ in^3$	

Answer: 2⅛" deep

4. Problem: How many 14-3/G NM-B cables are allowed in a 4 gang, 3½" deep gangable masonry box
which also contains 4 switches?

Solution:

3¾" × 2" × 3½" masonry box = 21 in^3	Table 314.16 (A)
21 in^3 × 4 gang = 84 in^3	
84 in^3 ÷ 2.0 in^3(14 AWG conductor) = 42	Table 314.16 (B)
42 - 8 (2 for each switch) = 34 14 AWG conductors	314.16 (B)(4)
34 - 1 (all grounding conductors) = 33	
33 ÷ 3 = 11 cables	

Answer: (11) 14-3/G NM-B cables

5. Problem: How many 12-2/G NM-B cables are allowed in a 4" × 1½" square box with internal cable clamps and a single gang plaster ring (with an additional 4 cubic inches) containing one duplex receptacle?

Solution:	$21 \text{ in.}^3 + 4 \text{ in.}^3 = 25 \text{ in.}^3$	Table 314.16 (A)
	$25 \text{ in.}^3 \div 2.25 \text{ in.}^3 = 11.1$ conductors	Table 314.16 (B)
	11 - 1 (all cable clamps) = 10 conductors	314.16 (B)(2)
	10 - 1 (all grounding conductors) = 9 conductors	314.16 (B)(5)
	9 - 2 (device) = 7 conductors	314.16 (B)(4)
	7 ÷ 2 = 3.5 cables	

Answer: (3) 12-2/G NM-B cables

Note 1: A very common calculation error is to give as an answer the number of wires instead of the number of cables. For example, if the conductor fill for an outlet box is (10) 12 AWG conductors, (3) 12-3/G NM-B cables or (4) 12-2/G NM-B cables may be installed. To determine the number of cables, all the grounding conductors are counted as one conductor and then the remaining conductors are divided by the number of wires per cable, excluding the grounding conductor.

Note 2: It is now required that looped conductors longer than twice the minimum required for free conductors in 300.14 (6 inches) to be counted as two conductors. (314.16 (B)(1) Conductor Fill)

Pull Boxes

To size pull boxes with raceways containing conductors of 4 AWG or larger:

- In straight pulls, the length of the box or conduit body shall not be less than eight times the trade diameter of the largest raceway. 314.28 (A)(1)

- Where splices, or where angle or U pulls are made, the distance between each raceway entry inside the box or conduit body and the opposite wall of the box or conduit body shall not be less than six times the trade size of the largest raceway in a row. This distance shall be increased for additional entries by the amount of the sum of the diameters of all other raceway entries in the same row on the same wall of the box. Each row shall be calculated individually, and the single row that provides the maximum distance shall be used. 314.28 (A)((2)

1. **Problem:** What size square pull box is required for (3) 2-inch conduits that feed straight through and each contain (3) 4/0 conductors?

Solution: 8 × 2" = 16" 314.28(A)(1)

Answer: 16" × 16" pull box

2. **Problem:** What size square pull box is required where (2) 2" conduits and (4) 1" conduits enter on each wall at 90 degree angles each containing conductors larger than 4 AWG?

Solution: 2" × 6 = 12" + 2" + 1" + 1" + 1" + 1" = 18" 314.28(A)(2)

Answer: 18" × 18" pull box

Note: The distance between raceway entries enclosing the same conductor shall not be less than six times the trade size of the larger raceway.

Verification of Attendance

Classroom:
Individuals are required to verify their contact information, license information, and sign-in at the beginning of class, certificates are handed out in person, only upon completion.

Online
Software used for online training has a "check-point" every 5 minutes, no interaction when prompted results in the program shutting down. Every 1-hour Element has a 5-question quiz that must be completed before moving on to the next section.

Following is a sample roster and certificate of completion.

Sample Roster

Bobo Technologies — City, St — Date

Initials	Name	Address	City, ST & ZIP	Home Phone#	Email	Company	Attending for . . .	Comments
JD	Doe, John	123 Elm Street	Denver, CO 80123	XXX) XXX-XXXX	JohnDoe@Email.com	John's Electric	CEUs CO	8 Hours Code Change
							RW JW MSTR	
							RW JW MSTR	
							RW JW MSTR	
							RW JW MSTR	
							RW JW MSTR	
							RW JW MSTR	
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							RW JW MSTR	
							RW JW MSTR	
							RW JW MSTR	

CERTIFICATE OF COMPLETION

2017 NEC® Continuing Education

awarded to

Gregory J Bragdon

CO License JW 106574 and ME 28690

2017 NEC® Continuing Education PROV0000002 INST0000001
March 9, 2019 - CO Course WM-2 8 Hours Wiring Methods
March 10, 2019 - CO Course TC-2 8 Hours Theory & Calculations
Colorado Springs, CO

Presented by

bobo technologies

PO Box 951
Palmer Lake, CO 80133
www.bobotechnologies.com

Larry D. Bobo

Larry D. Bobo, Owner / Instructor

2020 NEC Workshops

Code Changes / GB	April 4	Colordao Springs, CO
Day 1 Wiring Methods Day 2 Theory/Calc	April 18 - 19	Denver, CO
Day 1 Wiring Methods Day 2 Theory/Calc	April 24 - 25	Fraser, CO
Code Changes / GB	May 9	Denver, CO
Day 1 Wiring Methods Day 2 Theory/Calc	May 16 - 17	Glenwood Springs, CO
Day 1 Code Changes / Grounding Day 2 Wiring Methods Day 3 Theory/Calc	May 26 - 28	Golden, CO
Day 1 Wiring Methods Day 2 Theory/Calc	June 6 - 7	Colorado Springs, CO
Code Changes / GB	June 13	Grand Junction, CO
Day 1 Wiring Methods Day 2 Theory/Calc	July 11 - 12	Fort Collins, CO
Day 1 Code Changes / Grounding Day 2 Wiring Methods Day 3 Theory/Calc	July 21 - 23	Montrose, CO
Day 1 Wiring Methods Day 2 Theory/Calc	August 8 - 9	Pueblo, CO
Day 1 Wiring Methods Day 2 Theory/Calc	September 12 - 13	Denver, CO
Day 1 Wiring Methods Day 2 Theory/Calc	October 17 - 18	Grand Junction, CO
Day 1 Wiring Methods Day 2 Theory/Calc	November 14 - 15	Colorado Springs, CO
Day 1 Wiring Methods Day 2 Theory/Calc	December 8 - 9	Loveland, CO

State	Course Number	Approved Code Hours	Delivery	Approval Expiration
Arkansas - 2017 NEC Changes / **Statereporting.com**	1555	8.00	Online	8/21/2020
Colorado - Code Change / Grounding & Bonding	GB02-2 NECC02-3	8.00	Classroom	12/31/2020
Colorado - Code Change / Grounding & Bonding	GB02-2 NECC02-3	8.00	Online	12/31/2020
Colorado - Code Changes	NEECC - 2	8.00	Classroom	12/31/2020
Colorado - Grounding and Bonding	GB- 2	8.00	Classroom	12/31/2020
Colorado - Theory/Calcs	TC - 2	8.00	Classroom	12/31/2020
Colorado - Theory/Calcs	TC - 2	8.00	Online	12/31/2020
Colorado - Wiring Methods	WM - 2	8.00	Classroom	12/31/2020
Colorado - Wiring Methods	WM - 2	8.00	Online	12/31/2020
Montana - Code Changes	MTEL 20057	8.00	Classroom	8/1/2020
Montana - Electrical Theory and Calculations	MTEL20060	8.00	Classroom	8/1/2020
Montana - Electrical Theory and Calculations	MTEL20166	8.00	Online	8/1/2020
Montana - Grounding and Bonding	MTEL20058	8.00	Classroom	8/1/2020
Montana - Wiring Methods	MTEL20059	8.00	Classroom	8/1/2020
Montana - Wiring Methods	MTEL20061	8.00	Online	8/1/2020
Nebraska - Code Changes GB	20-206-CC-XXXXXX	8.00	Classroom	12/31/2020
Nebraska - Theory/Calcs	20-206-TC-XXXXXX	8.00	Classroom	12/31/2020
Nebraska - Theory/Calcs Online	20-206-TC-022020	8.00	Online	12/31/2020
Nebraska - Wiring Methods	20-206-WM-XXXXXX	8.00	Classroom	12/31/2020
Nebraska - Wiring Methods & TC Online	20-206-OCU-022020	12.00	Online	12/31/2020
Nebraska - Wiring Methods Online	20-206-UW-022020	8.00	Online	12/31/2020
New Mexico - Code Changes	2018-39	8.00	Classroom	5/16/2021
New Mexico - Grounding and Bonding	2018-40	8.00	Classroom	5/16/2021
New Mexico - Theory/Calcs	2018-38	8.00	Classroom	5/16/2021
New Mexico - Wiring Methods	2018-41	8.00	Classroom	5/16/2021
North Dakota - Code Changes	ND #17-129	8.00	Classroom	4/30/2020
North Dakota - Grounding and Bonding	ND #17-128	8.00	Classroom	4/30/2020
North Dakota - Theory/Calcs	ND #17-127	8.00	Classroom	4/30/2020
North Dakota - Wiring Methods	ND #17-130	8.00	Classroom	4/30/2020
South Dakota - Theory/Calcs	5224	8.00	Classroom	8/15/2020
South Dakota - Theory/Calcs Online	5225	8.00	Online	8/15/2020
South Dakota - Wiring Methods	5223	8.00	Classroom	8/15/2020
South Dakota - Wiring Methods Online	5226	8.00	Online	8/15/2020
South Dakota - Code Changes	5406	8.00	Classroom	8/15/2020
Utah - 2017NEC Code Changes	13645	8.00	Classroom	4/30/2020
Utah - Electrical Theory & Calculations	13649	8.00	Classroom	4/30/2020
Utah - Wiring Methods 2017NEC	13647	8.00	Classroom	4/30/2020
Washington - NEC Continuing Education	WA2018-690	16.00	Classroom	12/27/2021
Wyoming - 2017 NEC Continuing Education	WY17-268C	16.00	Classroom	6/30/2020
Wyoming - 2017 NEC Continuing Education - Theory and Calculations	WY17-269C	8.00	Online	6/30/2020
Wyoming - 2017 NEC Continuing Education - Wiring Methods	WY17-270C	8.00	Online	6/30/2020
Wyoming - Code Changes 2017 Analysis of Changes	WY17-365C	8.00	Classroom	6/30/2020
Wyoming - Electrical Theory & Calculations	WY17-368C	8.00	Classroom	6/30/2020
Wyoming - Grounding and Bonding	WY17-366C	8.00	Classroom	6/30/2020
Wyoming - NEC Continuing Education	WY17-215C	16.00	Classroom	6/30/2020
Wyoming - NEC Continuing Education - Theory and Calculations	WY17-214C	8.00	Online	6/30/2020
Wyoming - NEC Continuing Education - Wiring Methods	WY17-213C	8.00	Online	6/30/2020
Wyoming - Wiring Methods	WY17-367C	8.00	Classroom	6/30/2020

Instructor: Larry Bobo NEC2020 Continuing Education
Course ID:

Thank you for taking just a moment to complete this evaluation.

What is your reason for attending this workshop? *(Circle One)*

Continuing Education *Residential License* *Journeyman License* *Masters License*

Attendee Name (Optional): ______________________________

Contact Information: ______________________________

____

Please circle your most appropriate response. (1=Poor 5=Outstanding)

1.	The material was presented in a clear, easy to understand, manner.	1	2	3	4	5
2.	Topics were thoroughly covered in the time allotted.	1	2	3	4	5
3.	Visual examples and or demonstrations were used effectively.	1	2	3	4	5
4.	The instructor was well prepared.	1	2	3	4	5
5.	The instructor was knowledgeable of the subject matter.	1	2	3	4	5
6.	The instructor answered questions thoroughly.	1	2	3	4	5
7.	Rate the quality of the workbook your received.	1	2	3	4	5

9. What questions did you have that were not covered during the workshop?

____

____

____

10. What was the most useful information you received?

____

____

____

Please include any additional comments or suggestions you may have regarding this workshop.

____

____

____

Bobo Technologies P.O. Box 951 Palmer Lake, CO 80133 Phone/FAX 719.488.2632