
# Overcurrent Protection (2017 NEC) (Homestudy)

## Idaho Electrical License

This course will review the 2017 National Electrical Code as it relates to overcurrent protection. The key pieces of Article 240 will be covered along with overcurrent protection for panelboards, appliances, motors, motor compressors, transformers, and fire pumps. The requirements for ground-fault protection for personnel and arc-fault circuit-interrupter protection are also presented.

**Course# 20-621649     4 Industry Related (IR) Credit Hours     $55.00**

This course is currently approved by the Idaho Electrical Bureau under course number 20-621649.

Completion of this continuing education course will satisfy 4.000 credit hours of course credit type 'Industry Related (IR)' for Electrical license renewal in the state of Idaho. Course credit type 'Industry Related (IR)'. Board issued approval date: 4/26/2018. Board issued expiration date: 2/25/2020.

# Overcurrent Protection (2017 NEC) (Homestudy) - ID

## Question 1: 240.1 Overcurrent Protection. Scope. Informational Note.

Question ID#: 11331.0

***Section 240.1 Overcurrent Protection Informational Note*** gives a one sentence statement about the purpose of overcurrent protection in electrical systems. It says: ***Overcurrent protection for conductors and equipment is provided to open the circuit if the current reaches a value that will cause an excessive or dangerous temperature in conductors or conductor insulation.***



***The purpose of overcurrent protection is to prevent the insulation on conductors from being damaged.***

Overcurrent protection is primarily about protecting conductors and conductor insulation. If a conductor is overloaded the insulation gets overheated and it will get brittle, crack, or fall off. If that happens a ground-fault may occur creating an electrical shock hazard. One purpose of overcurrent protection is to prevent damage to the conductor.

Of course another important purpose of overcurrent protection is to isolate the electrical fault from the rest of the system and protect equipment, but as stated here, the main purpose of fuses and circuit breakers is to protect wires. Continued operation of electrical distribution systems depends on the integrity of conductor insulation. Wire size (the current-carrying capacity) and overcurrent protection (circuit breaker or fuse) are matched so if the current on a conductor increases to the point where the insulation is being damaged, the overcurrent device will de-energize the circuit and protect the conductor.

Question 1: What is the main purpose of overcurrent protection?

A: To prevent more than a single device from being connected to a branch circuit.
B: To prevent voltage drop on long runs of copper conductors.
C: To prevent the copper or aluminum in a conductor from melting.
D: To protect the insulation on conductors and prevent it from overheating.

## Question 2: 240.1 Overcurrent Protection. Scope. Informational Note.

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Question 2: A 200-Amp panelboard is used as service equipment in a dwelling. The purpose of the individual circuit-breakers in the panelboard is to provide all of the following functions except one. Select the one function NOT provided by the circuit breakers in the panelboard.

A: The circuit breakers make certain the branch circuit conductor material (aluminum or copper) doesn't get overloaded and overheated.
B: The circuit breakers make certain the branch circuit conductor insulation doesn't get overloaded and overheated.
C: The circuit breakers make certain electricians do not tie together too many white grounded conductors in junction boxes scattered throughout the dwelling.
D: The circuit breakers make certain the branch circuit conductors don't stay energized if one of the ungrounded (energized) branch circuit conductors comes into contact with grounded metal.

## Question 3: 110.9 Interrupting Rating.

Question ID#: 11332.0


***The interrupting rating of a circuit breaker is how much fault current it can safely withstand without becoming a hazard.***

Overcurrent protective devices like circuit breakers and fuses provide both overload protection and short-circuit/ground-fault protection. They are rated according to their trip setting if a circuit breaker or the amount of current that causes a fuse link to melt. Both fuses and circuit breakers are also classified according to their interrupting rating.

The interrupting rating of a fuse or circuit breaker is the amount of current it can break (interrupt), safely without exploding or creating a fire hazard. A typical residential type branch circuit breaker has an interrupting rating of 10,000 amps.

If a typical 20-amp residential type circuit breaker interrupted a 10,000-amp fault, it might not be able to be put back into service, but it should safely contain the arcing that occurs within the circuit breaker when it interrupts the 10,000-amp short-circuit or ground-fault current.

The Code defines an "Overcurrent Protective Device, Branch Circuit" in Article 100 as "a device capable of providing protection for service, feeder, and branch circuits." It requires the minimum interrupting rating for these devices to be not less than 5,000 amperes.

The Code does not require all fuses and circuit breakers to be marked with their interrupting rating. Fuses that have an interrupting rating of 10,000 amps do not have to be marked. See 240.60(C) for fuse marking requirements. Circuit breakers with an interrupting rating of 5,000-amps do not have to be marked. See 240.83 for circuit breaker marking requirements. A fuse that is not marked has an interrupting rating of 10,000 amps. A circuit breaker that is not marked has an interrupting rating of 5,000 amps. All other fuses and circuit breakers are required to be marked with their interrupting rating.

When overcurrent devices are exposed to fault-current levels above their interrupting rating the arc flash and arc blast pose a serious threat to electrical workers and anyone else in the area. It is very important that the interrupting rating of overcurrent devices is equal to or greater than the available short-circuit current to protect both personnel and equipment.

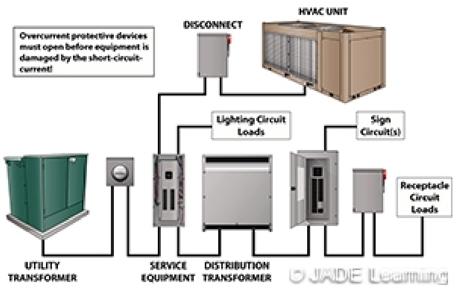
Upgrading an electrical service may change the required interrupting rating of the overcurrent devices. If the utility company installs larger transformers to supply the new service, the fault current may be greater than the interrupting rating of the existing overcurrent protective devices. This can create a very dangerous situation and it must be corrected. The interrupting rating of the fuses or circuit breakers must always be equal to or greater than the available fault-current available at the line terminals of the overcurrent devices.

Question 3: The available short circuit current at the terminals of a circuit breaker is 15,000 amps. The interrupting rating must be:

A: Selected to protect the insulation on the conductors.
B: Twice the rating of the available short circuit current.
C: A minimum of 15,000 amps.
D: A minimum of 10,000 amps.

## Question 4: 110.10 Circuit Impedance and Other Characteristics.

Question ID#: 11333.0




***Equipment, disconnects, and busduct all have short circuit ratings which must not be exceeded.***

If a major fault occurs in an electrical system, more than just the overcurrent devices are affected. High levels of short-circuit current can damage bus bars, disconnects, panelboards and other electrical equipment. All of these components have maximum short-circuit current ratings. The short-circuit current ratings of equipment must be coordinated with overcurrent protective devices to insure a fault anywhere in the system is safely contained before the fault-current exceeds the short-circuit rating of the equipment in the circuit.

Part of the job of overcurrent devices is to keep the amount of fault-current within the short-circuit ratings of each downstream component in the system. The circuit protective device(s) must clear the fault without allowing the high levels of current to pass through which would cause damage to circuit components. If short-circuit current ratings are exceeded the electrical equipment may fail causing a fire or injury to persons in the area.

The circuit components must be designed and built strong enough to withstand short-circuit currents within its short-circuit current rating until an overcurrent device opens and clears the fault. The amount of current that busbars and other circuit components can withstand without extensive damage is their short-circuit current rating. The short-circuit current rating of electrical equipment, such as control panels or panelboards, is limited to the lowest rated individual electrical component in the enclosure.

Question 4: What is the maximum allowable short circuit current for a feeder that has equipment with the following short circuit ratings: busbar 100,000 amps and disconnect switches rated 60,000 amps?

A: 10,000 amps.
B: 75,000 amps.
C: 60,000 amps.
D: 100,000 amps.

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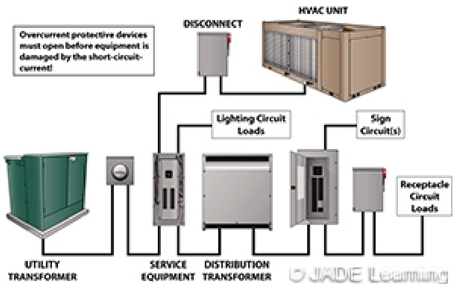


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Question 5: What happens if the short-circuit current of a fault is greater than the interrupting rating of the overcurrent protective device?

A: The circuit breaker will not trip.
B: The circuit breaker will trip slower.
C: The circuit breaker will trip faster.
D: The circuit breaker could explode.

## Question 6: 110.14(C) Temperature Limitations of Terminals.

Question ID#: 11334.0


***The temperature rating of the wire must be equal to or greater than the temperature rating of the terminal. A 60/75 degree rating can be rated at 75 degree C.***

Circuit breakers and fuseholders have terminals to attach wires to the circuit breaker or fuseholder. In fact, a circuit breaker is an assembly which includes the tripping mechanisms and the means to attach a conductor. A fuseholder is also an assembly which is made to hold a fuse of a certain voltage and current rating and the means to connect a conductor. If the terminal for a conductor gets overheated it can adversely affect the operation of the fuse or circuit breaker.

To prevent overheating at the terminals, Section 110.14(C) requires the temperature rating used to determine conductor ampacity to not exceed the temperature rating of any connected termination in the circuit. The UL marking guide for Molded Case Circuit Breakers explains: ***All circuit breakers rated 125A or less are marked for use with 60Â°C, 60/75Â°C, or 75Â°C only wire. This marking indicates the proper wire size for termination in accordance with Table 310.15(B)(16) of the NEC. It is acceptable to use wire with a higher insulation rating if the ampacity is based on the wire temperature rating marked on the breaker.***

Most terminals today are marked 60/75***Â°***C or 75***Â°***C. This means that whatever the rating of the overcurrent device, the 75***Â°***C rating of the wire, taken from Table 310.15(B)(16), can be used to select the conductor. Termination provisions in older existing equipment, such as panelboards, may not be marked with a temperature rating. If the equipment is rated 100 amps or less and the equipment terminal is not marked, or the terminal is marked for 60***Â°***C conductors, the ampacity of the conductor must not exceed the ampacity listed in the 60***Â°***C column of Table 310.15(B) (16). This ensures that the conductor temperature does not get hotter than the terminal is rated for.

***Example 1:*** A 90oC rated No. 4 AWG THHN copper conductor is terminated on a 60oC rated terminal in a panelboard.

According to Table 310.15(B) (16), a 90oC rated No. 4 AWG, THHN copper conductor has an allowable ampacity of 95 amps. The conductor is good for 95 amps, but the load in amps on the conductor must not exceed the ampacity based on the temperature rating of the terminals. The 60oC ampacity of the No. 4 conductor is 70 amps.

If the conductor ampacity was based on the 90oC rated ampacity of 95 amps, the conductor temperature would exceed the 60oC terminal temperature rating whenever the load on the conductor exceeded 70 amps.

***Example 2:*** If there were 3 current-carrying No. 6 AWG, THHN, copper conductors installed in a raceway in an 86***Â°***F (30 degree C) ambient temperature, what is the ampacity of the conductors when connected to a breaker marked with a terminal temperature rating of 60/75***Â°***C like the one in the illustration?

The THHN conductor is in the 90***Â°***C column of Table 310.15(B)(16). According to the table, the 90***Â°***C column indicates the ampacity of the No. 6 conductor is 75 amps. However, because the terminal temperature rating of the breaker is 60/75 ***Â°***C, the conductor's ampacity is limited to 65 amps, which is indicated in the 75***Â°***C column. If the breaker was marked with a 60***Â°***C rating only, the ampacity of the No. 6 AWG THHN copper conductor would be limited to 55 amps.

In general, the 90***Â°***C ampacity rating for conductors is only used when applying correction factors for ambient temperature and more than 3 current carrying conductors in a raceway or cable.

Question 6: What is the minimum size THHN conductor that can be used for a 100 amp circuit breaker with 75Â°C rated terminals?

A: 1/0 AWG cu.
B: No. 3 AWG cu.
C: No. 1 AWG cu.
D: No. 2 AWG cu.

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Most terminals today are marked 60/75***Â°***C or 75***Â°***C. This means that whatever the rating of the overcurrent device, the 75***Â°***C rating of the wire, taken from Table 310.15(B)(16), can be used to select the conductor. Termination provisions in older existing equipment, such as panelboards, may not be marked with a temperature rating. If the equipment is rated 100 amps or less and the equipment terminal is not marked, or the terminal is marked for 60***Â°***C conductors, the ampacity of the conductor must not exceed the ampacity listed in the 60***Â°***C column of Table 310.15(B) (16). This ensures that the conductor temperature does not get hotter than the terminal is rated for.

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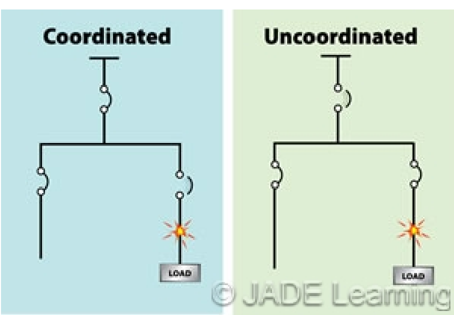
In general, the 90***Â°***C ampacity rating for conductors is only used when applying correction factors for ambient temperature and more than 3 current carrying conductors in a raceway or cable.

Question 7: What is the minimum size THWN-2 copper conductor that is protected by a 125-amp circuit breaker with 75Â° C terminals?

A: No. 1/0 AWG.
B: No. 1 AWG.
C: No. 3 AWG.
D: No. 2 AWG.

## Question 8: Article 100 Definitions: Coordination (Selective).

Question ID#: 11335.0




***In a coordinated electrical system the overcurrent device immediately ahead of the fault will de-energize the circuit. In uncoordinated systems a feeder breaker or even the service breaker could trip on a branch circuit fault.***

Coordination, Selective. ***Localization of an overcurrent condition to restrict outages to the circuit or equipment affected, accomplished by the selection and installation of overcurrent protective devices and their ratings or settings for the full range of available overcurrents, from overload to the maximum available fault current, and for the full range of overcurrent protective device opening times associated with those overcurrents.***

Proper electrical coordination prevents upstream circuit breakers from tripping before the downstream breaker closest to a short-circuit or ground-fault opens to clear the fault. If an electrical distribution system is coordinated, a fault on a branch circuit will not trip the upstream circuit breaker supplying the branch circuit panelboard. The circuit breaker protecting the branch circuit will open and the fault is isolated to just a small part of the electrical system. This is especially important in hospitals or other locations where losing power to a panelboard could have serious consequences.

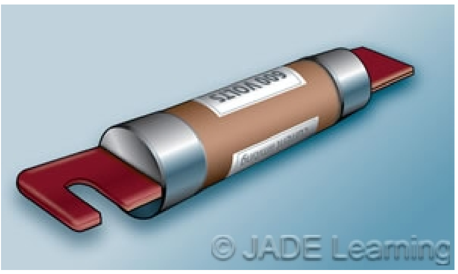
Systems may be coordinated according to how large the fault is or how long the fault lasts. In either case, the upstream breaker has to hold until the downstream breaker can clear the fault. For example, if time is used to coordinate the system, the time delay on the upstream breaker must be longer than the maximum amount of time the downstream breaker takes to clear the fault. When upstream overcurrent devices trip before downstream devices, it usually is because the downstream breaker did not trip fast enough. When this happens, large parts of the system will lose power because the fault is not localized by the downstream device.

Question 8: In a coordinated system of overcurrent devices:

A: The time delay for the upstream device is less than the time delay for the downstream device.
B: The feeder breaker trips before the branch circuit breaker.
C: The downstream overcurrent device nearest the fault is the first to trip.
D: The upstream device trips before the downstream device.

## Question 9: 240.2 Definitions: Current-Limiting Overcurrent Protective Device.

Question ID#: 11336.0




***A current-limiting device acts within the first half-cycle to de-energize the circuit before the current can reach its maximum value.***

A Current-Limiting Overcurrent Protective Device is: ***A device that, when interrupting currents in its current-limiting range, reduces the current flowing in the faulted circuit to a magnitude substantially less than that obtainable in the same circuit if the device were replaced with a solid conductor having comparable impedance.***

Many large commercial and industrial electrical systems have enormous amounts of available fault current. Overcurrent devices with high enough interrupting ratings to deal with huge levels of available fault current are very expensive. It is much more practical to reduce the level of available fault current at a device, rather than buy overcurrent devices with high interrupting ratings that can handle the fault currents.

If there is a fault, a current-limiting fuse will open much faster than other fuses or standard inverse time circuit breakers. It can act within a half cycle to cut off the destructive fault currents before they reach their maximum intensity. A short circuit or ground fault will build to its highest level within 2 or 3 cycles. The fault current will rise to the maximum level that the electrical source can pump into the fault. The fault current will stay at these high levels until something gives or burns loose. If action is not taken before the currents reach peak values in the first half cycle then the maximum available fault current will flow through the system components.

Downstream overcurrent devices are permitted to have interrupting ratings that match the let-through current of the current-limiting device. For example, if a system has 100,000 amps of available fault current, but a current-limiting fuse limits the fault current to 10,000 amps, downstream components with 10,000 amp interrupting ratings can be used.

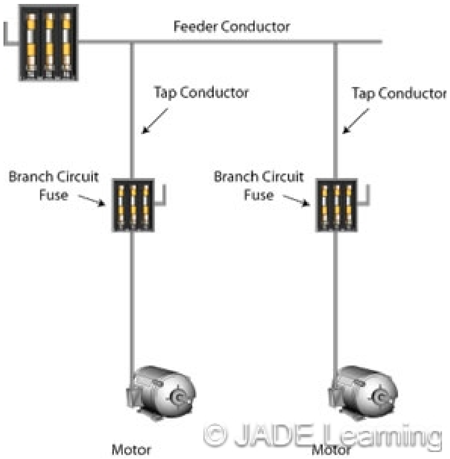
Fuseholders for current-limiting fuses must have rejection clips to prevent a current-limiting fuse from being replaced with a non-current-limiting fuse.

Question 9: A current-limiting fuse:

A: Does not limit let-through fault-current.
B: Will open within 1/2 cycle - before fault current reaches maximum values.
C: Has a longer time delay than a standard fuse.
D: Is used more for circuit overloads than short circuits.

## Question 10: 240.2 & 240.21 Definitions: Tap Conductors.

Question ID#: 11337.0




***A tap conductor has overcurrent protection in excess of the value of the conductor.***

The Code definition is: ***As used in this article, a tap conductor is defined as a conductor, other than a service conductor, that has overcurrent protection ahead of its point of supply that exceeds the value permitted for similar conductors that are protected as described elsewhere in 240.4.***

Tap conductors are exceptions to the rule that conductors must be protected at the point where they are connected to an electrical source (240.21). Tap conductors are an important exception because the main purpose of Article 240 is to protect conductors.

The limited overcurrent protection a tap conductor has is from the upstream feeder or branch circuit breaker, but the upstream breaker has been sized to protect the feeder or branch circuit, not the tap. Because tap conductors do not have the standard overcurrent protection, they are more dangerous than protected wires, and there are important Code rules for the size, length, and wiring method used for tap conductors.

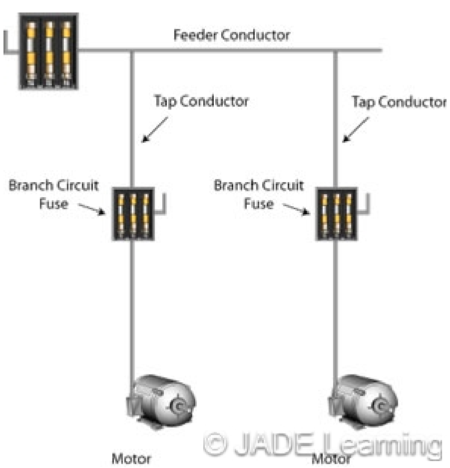
Service conductors are not included in the definition of tap conductors because service conductors have their own rules. Service conductors may be tapped (230.46), but the ampacities of the tap conductors are determined by Article 230, not Article 240.

Question 10: Tap conductors:

A: Are always larger than the branch circuit conductors.
B: Are protected by the feeder fuse at their ampacity.
C: Have overcurrent protectionÂ ahead ofÂ the point of supply that exceeds the ampacity of the tap conductor.
D: Are twice the size of the branch circuit conductors.

## Question 11: 240.2 & 240.21 Definitions: Tap Conductors.

Question ID#: 11337.1

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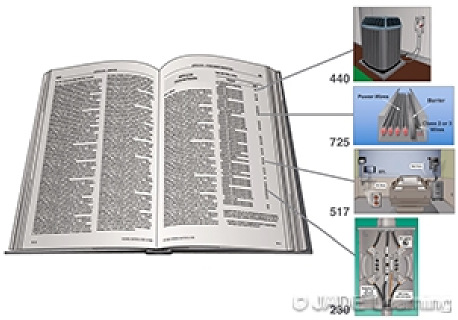
Question 11: Which of the following statements about overcurrent protection for tap conductors is correct?

A: Tap conductors do not require overcurrent protection at the point where they are connected to the feeder.
B: The overcurrent protection is located where the tap is connected to the feeder.
C: Tap conductors are protected by overcurrent devices with ratings less than branch circuit conductors.
D: Tap conductors are not permitted at the service.

## Question 12: 240.3 Other Articles: Protecting Equipment.

Question ID#: 11338.0




***Section 240.3 lists other Articles that should be consulted when protecting equipment like welders, fire pumps, motors, and transformers.***

Article 240 concerns general rules governing overcurrent protective devices and is primarily concerned with protection of conductors. Different overcurrent protection rules may apply to specific equipment such as motors, elevators and fire pumps. Articles associated with equipment that is not covered in Article 240 are listed in Table 240.3, Other Articles. The requirements for overcurrent protective devices used to protect specific types of equipment listed in the Table are not found in article 240. Rules for protecting equipment listed in Table 240.3 are found in articles that deal specifically with that type of equipment.

For example, the requirements for the overcurrent protection of transformers can be found in article 450 not article 240. The list of Articles given in Table 240.3 is in alphabetical order by type of equipment, not in numerical order. Table 240.3 is a reference for users to consult when making sure both the equipment and conductors are protected against overloads, short circuits, and ground faults.

A plant manager at an industrial facility will not be pleased if the facility burns down because the conductors supplying the fire pump were protected from overload in accordance with the general rules in Article 240. The other articles in the NEC must be consulted where conductors supply the specific types of equipment listed in Table 240.3.

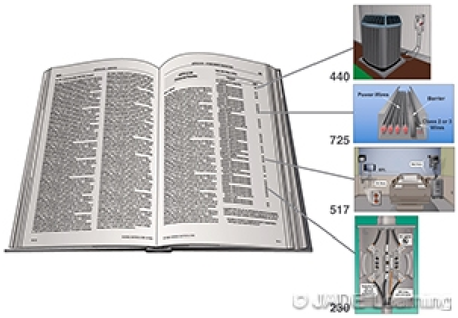
It is typical design practice to provide protection for conductors as close to their maximum allowable ampacities as possible. If a load draws 63 amps, the best protection for the conductors is as close to 63 amps as possible, but overcurrent protection for some equipment must often take into account other factors like inrush current and continuous loading.  Also, an equipment manufacturer may require a specific size fuse or circuit breaker based on the listing and labeling requirements of their equipment. If the manufacturer specifies a specific rating or type of overcurrent device then that is the rating or type of overcurrent protection that must be used (110.3B).

Question 12: You are installing a branch circuit for a large motor.  According to Table 240.3, which lists other code articles that have the requirements for specific pieces of equipment, which Code article will have the requirements for protecting the motor circuit?

A: Article 430.
B: Article 250.
C: Article 210.
D: Article 240.

## Question 13: 240.3 Other Articles: Protecting Equipment.

Question ID#: 11338.1

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A plant manager at an industrial facility will not be pleased if the facility burns down because the conductors supplying the fire pump were protected from overload in accordance with the general rules in Article 240. The other articles in the NEC must be consulted where conductors supply the specific types of equipment listed in Table 240.3.

It is typical design practice to provide protection for conductors as close to their maximum allowable ampacities as possible. If a load draws 63 amps, the best protection for the conductors is as close to 63 amps as possible, but overcurrent protection for some equipment must often take into account other factors like inrush current and continuous loading. Also, an equipment manufacturer may require a specific size fuse or circuit breaker based on the listing and labeling requirements of their equipment. If the manufacturer specifies a specific rating or type of overcurrent device then that is the rating or type of overcurrent protection that must be used (110.3B).

Question 13: Which of the following specifies requirements for determining the overcurrent protection for branch-circuits supplying Fire Pumps?

A: Article 402.
B: Article 695.
C: Article 400.
D: Article 650.

## Question 14: 240.4 Protection of Conductors.

Question ID#: 11339.0


***If the ampacity of a conductor is reduced because there are more than 3 current-carrying conductors in a raceway, the conductor must be protected at its reduced ampacity.***

The general rule is that conductors must be protected according to their ampacities as determined by section 310.15. What does section 310.15 say about selecting conductors?

- Voltage drop is not taken into consideration.
- How much current a conductor can carry is affected by the ambient temperature and the
- For dwelling units that have single-phase services rated from 100 to 400 amps, the servi
- Conductor ampacity is selected from tables 310.15(B)(16) - 310.15(B)(21) unless calcula
- The ampacity of conductors in conduits on rooftops exposed to sunlight must be adjusted

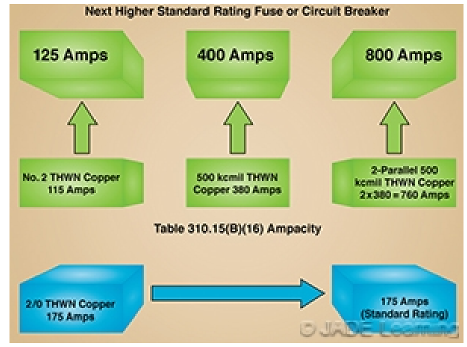
Conductors are protected according to their ampacities, even if they are derated. For example, if 4-6 current-carrying conductors are in conduit their wires can only carry 80% of the values listed in Table 310.15(B)(16). According to the table, a No. 3 AWG Type THW (75C) copper wire has an allowable ampacity of 100 amps. If it is derated to 80% because of the ambient temperature or because there are more than 3 current-carrying conductors in a raceway, it can only carry 80 amps. The maximum overcurrent protection for the No. 3 AWG CU conductor is 80 amps, not 100 amps.
Another example: A No. 4 AWG Type THW CU wire has an allowable ampacity of 85 amps in Table 310.15(B)(16). If it is derated 80% it can only carry 68 amps (85 X 0.80 = 68). The next standard rating for overcurrent protection that could be used is 70 amps, not 80, 85, or 90 amps. Conductors must be protected according to their ampacities. Derating a conductor gives it a new maximum ampacity. The conductor must be protected at that new ampacity. However, for overcurrent devices rated 800-amperes or less, section 240.4(B)(1-3) gives permission to use the next higher standard size overcurrent protective device when the conductor ampacity does not correspond with the standard rating of overcurrent protective devices listed in 240.6(A).

Question 14: A 1/0 AWG conductor can carry 150 amps. If it is installed in a raceway with 3 other current-carrying conductors it must be derated to 80% of its current-carrying capacity. What is the maximum size of the overcurrent protection allowed?

A: 150 amps.
B: 100 amps.
C: 125 amps.
D: 110 amps.

## Question 15: 240.4(B) Devices Rated 800 Amperes or Less.

Question ID#: 11340.0




***The next higher standard size overcurrent protective device can be used to protect a conductor, up to 800 amps.***

Conductors are protected according to their ampacities. However, the next higher standard overcurrent device rating can be used if all of the following conditions are met:

- The ampacity of the conductor does not match a standard overcurrent device rating listed in Table 240.6(A).
- The conductors being protected are not part of a multioutlet branch circuit supplying more than one receptacle for cord-and-plug connected portable loads.
- The next higher standard overcurrent device rating is not over 800 amps.

A conductor's ampacity must always be equal to or greater than the load it will supply. But the rating of overcurrent protective device (fuse or circuit breaker) protecting the conductor can be greater than the conductor ampacity if the three conditions listed above are met.

For example, a conductor rated at 65 amps can be protected at 70 amps. A conductor rated at 85 amps can be protected at 90 amps and a conductor rated at 380 amps can be protected at 400 amps. The conductor is still considered to be protected even if the next standard size is used as long as the next standard rating does not exceed 800 amps. Where the ampacity of the conductor equals a standard rating for an overcurrent device, the next higher standard rating cannot be used. For example, a 3/0 THW copper conductor has an ampacity of 200 amps. Since 200 amps is a standard rating for a fuse or circuit breaker, the next higher standard rating cannot be used.

The conductors for a 20-amp branch circuit that supplies more than one receptacle for cord-and-plug connected portable loads in a residential, commercial, or industrial location must be rated at least 20 amps. They could not be rated 18 amps and protected by a 20-amp circuit breaker. Likewise, conductors protected by a 15-amp fuse or circuit breaker must be rated for the full 15 amps.

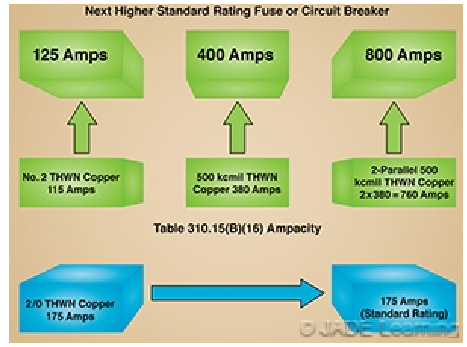
Since it is impossible to predict what will be plugged into a receptacle, and very possible that receptacle circuits will be overloaded, the NEC requires the branch circuit conductors supplying receptacle outlets for portable loads to have an ampacity not less than the rating of the overcurrent device protecting the circuit.

Question 15: A No. 6 AWG wire rated at 65 amps is run to a single appliance. What is the maximum standard size branch circuit breaker allowed?

A: 75 amps.
B: 60 amps.
C: 70 amps.
D: 80 amps.

## Question 16: 240.4(B) Devices Rated 800 Amperes or Less.

Question ID#: 11340.1




***The next higher standard size overcurrent protective device can be used to protect a conductor, up to 800 amps.***

Conductors are protected according to their ampacities. However, the next higher standard overcurrent device rating can be used if all of the following conditions are met:

- The ampacity of the conductor does not match a standard overcurrent device rating listed in Table 240.6(A).
- The conductors being protected are not part of a multioutlet branch circuit supplying more than one receptacle for cord-and-plug connected portable loads.
- The next higher standard overcurrent device rating is not over 800 amps.

A conductor's ampacity must always be equal to or greater than the load it will supply. But the rating of overcurrent protective device (fuse or circuit breaker) protecting the conductor can be greater than the conductor ampacity if the three conditions listed above are met.

For example, a conductor rated at 65 amps can be protected at 70 amps. A conductor rated at 85 amps can be protected at 90 amps and a conductor rated at 380 amps can be protected at 400 amps. The conductor is still considered to be protected even if the next standard size is used as long as the next standard rating does not exceed 800 amps. Where the ampacity of the conductor equals a standard rating for an overcurrent device, the next higher standard rating cannot be used. For example, a 3/0 THW copper conductor has an ampacity of 200 amps. Since 200 amps is a standard rating for a fuse or circuit breaker, the next higher standard rating cannot be used.

The conductors for a 20-amp branch circuit that supplies more than one receptacle for cord-and-plug connected portable loads in a residential, commercial, or industrial location must be rated at least 20 amps. They could not be rated 18 amps and protected by a 20-amp circuit breaker. Likewise, conductors protected by a 15-amp fuse or circuit breaker must be rated for the full 15 amps.

Since it is impossible to predict what will be plugged into a receptacle, and very possible that receptacle circuits will be overloaded, the NEC requires the branch circuit conductors supplying receptacle outlets for portable loads to have an ampacity not less than the rating of the overcurrent device protecting the circuit.

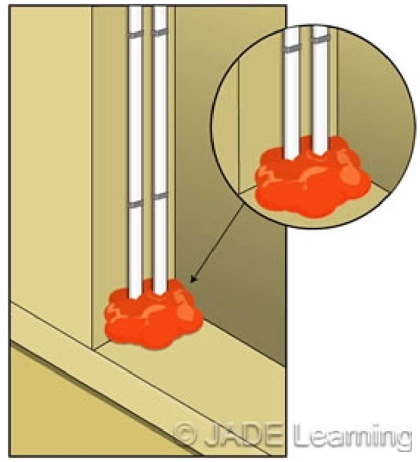
Question 16: The ampacity of three paralleled 500 kcmil conductors is 1140 amps. What is the maximum rating of an overcurrent device protecting these conductors?

A: 1300 amps.
B: 1200 amps.
C: 800 amps.
D: 1000 amps.

## Question 17:   240.4(D)  Small Conductors.

Question ID#: 11341.0

Unless specifically permitted in 240.4(E) or (G), Section 240.4(D) limits the overcurrent protection for No. 14 AWG copper conductors to 15 amps, No. 12 AWG copper conductors to 20 amps, and No. 10 AWG copper conductors to 30 amps. The ratings are well known because these wires are the most common branch circuit sizes.




***Use the wire ratings from Table 310.15(B)(16) when derating conductors. OC protection is still limited to 30 amps for No. 10 AWG, 20 amps for No. 12 AWG, and 15 amps for No. 14 AWG.***

The overcurrent protection of small aluminum and copper-clad aluminum conductors are also limited by this section. Overcurrent protection for No. 12 AWG copper-clad aluminum conductors is limited to 15 amps, while No. 10 AWG copper-clad aluminum conductors must be protected at no more than 25 amps.

It gets more confusing when using Table 310.15(B)(16), though, because the values in the table are higher than the allowable overcurrent protection permitted for small conductors by 240.4(D).

For 75Â°C conductors, Table 310.15(B)(16) rates a No. 14 AWG at 20 amps, a No. 12 AWG at 25 amps, and a No. 10 AWG at 35 amps. The higher ampacity ratings of Table 310.15(B)(16) for No. 14, No. 12, and No. 10 AWG conductors are used when correcting the ampacity of a conductor because of high ambient temperatures or where ampacity must be adjusted for more than 3 current-carrying conductors in a raceway or cable. However, unless permitted by 240.4(E) for tap conductors or 240.4(G) for specific conductor applications, a No. 14 AWG copper conductor cannot be protected at more than 15 amps, a No. 12 AWG copper conductor cannot be protected at more than 20 amps, and a No. 10 AWG copper conductor cannot be protected at more than 30 amps, per section 240.4(D).

For example, a No. 12 AWG nonmetallic sheathed cable is used on a branch circuit that supplies receptacles. Since the circuit is a multi-outlet branch circuit for cord-and-plug connected portable loads, the ampacity of the wire must be equal to or larger than the rating of the fuse or circuit breaker protecting the circuit.

If three NM cable are bundled together or if the three cables pass through an opening that is fire-stopped, the ampacity of each wire must be reduced to 80% of the value in Table 310.15(B)(16). The wire inside a nonmetallic sheathed cable is rated for 90 degrees C.  The 90 degree C rating of a No. 12 conductor is 30 amps.  30 amps x 80% = 24 amps.

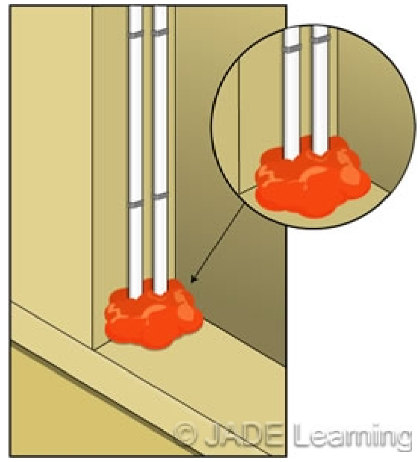
The circuit must still be protected at 20 amps. The point is that 240.4(D) limits the size of the overcurrent protection.  If ampacity adjustment is required for a small conductor it starts with the values for conductors in Table 310.15(B)(16), not the values of small conductors in 240.4(D).

Question  17:   What is the maximum size overcurrent protection for a No. 10 Type THHN conductor with an ampacity rating of 40 amps?

A: 25 amps.
B: 40 amps.
C: 35 amps.
D: 30 amps.

## Question 18:  240.4(D)  Small Conductors.

Question ID#: 11341.1




***Use the wire ratings from Table 310.15(B)(16) when derating conductors. OC protection is still limited to 30 amps for No. 10 AWG, 20 amps for No. 12 AWG, and 15 amps for No. 14 AWG.***

Unless specifically permitted in 240.4(E) or (G), Section 240.4(D) limits the overcurrent protection for No. 14 AWG copper conductors to 15 amps, No. 12 AWG copper conductors to 20 amps, and No. 10 AWG copper conductors to 30 amps. The ratings are well known because these wires are the most common branch circuit sizes.

The overcurrent protection of small aluminum and copper-clad aluminum conductors are also limited by this section. Overcurrent protection for No. 12 AWG copper-clad aluminum conductors is limited to 15 amps, while No. 10 AWG copper-clad aluminum conductors must be protected at no more than 25 amps.

It gets more confusing when using Table 310.15(B)(16), though, because the values in the table are higher than the allowable overcurrent protection permitted for small conductors by 240.4(D).

For 75Â°C conductors, Table 310.15(B)(16) rates a No. 14 AWG at 20 amps, a No. 12 AWG at 25 amps, and a No. 10 AWG at 35 amps. The higher ampacity ratings of Table 310.15(B)(16) for No. 14, No. 12, and No. 10 AWG conductors are used when correcting the ampacity of a conductor because of high ambient temperatures or where ampacity must be adjusted for more than 3 current-carrying conductors in a raceway or cable. However, unless permitted by 240.4(E) for tap conductors or 240.4(G) for specific conductor applications, a No. 14 AWG copper conductor cannot be protected at more than 15 amps, a No. 12 AWG copper conductor cannot be protected at more than 20 amps, and a No. 10 AWG copper conductor cannot be protected at more than 30 amps, per section 240.4(D).

For example, a No. 12 AWG nonmetallic sheathed cable is used on a branch circuit that supplies receptacles. Since the circuit is a multi-outlet branch circuit for cord-and-plug connected portable loads, the ampacity of the wire must be equal to or larger than the rating of the fuse or circuit breaker protecting the circuit.

If three NM cable are bundled together or if the three cables pass through an opening that is fire-stopped, the ampacity of each wire must be reduced to 80% of the value in Table 310.15(B)(16). The wire inside a nonmetallic sheathed cable is rated for 90 degrees C.  The 90 degree C rating of a No. 12 conductor is 30 amps.  30 amps x 80% = 24 amps.

The circuit must still be protected at 20 amps. The point is that 240.4(D) limits the size of the overcurrent protection.  If ampacity adjustment is required for a small conductor it starts with the values for conductors in Table 310.15(B)(16), not the values of small conductors in 240.4(D).

Question 18:   What is the maximum size overcurrent protection permitted for a No. 12 AWG THWN-2 copper conductor that has an ampacity of 30 amps from the 90Â°C column of Table 310.15(B)(16)?

A: 15 amps.
B: 25 amps.
C: 20 amps.
D: 30 amps.

## Question 19: 240.5 Protection of Flexible Cords, Flexible Cables, and Fixture Wires.

Question ID#: 11342.0


***The ampacity of conductors in flexible cords is selected from Table 400.5(A)(1) and (A)(2).***

Like branch circuit conductors, flexible cords, flexible cables, and fixture wires are protected according to their ampacity, but the ampacity of cords, cables, and fixture wires is different than the values found in Table 310.15(B)(16) for branch circuit conductors. The current-carrying capacity for cords and cables is found in Table 400.5(A)(1) & Table 400.5(A)(2). The ampacity for fixture wires is found in Table 402.5.

One important difference about protecting flexible cords, cables, and fixture wires is that supplementary overcurrent protection, such as what is often found in HID lighting, is an acceptable way to protect these types of wires.

Also, the supply cords of listed appliances and permanent and portable luminaires are considered protected when used within the listing requirements of the appliance or portable lamp. Extension cord sets are also considered protected if used within the requirements of the extension cord listing, which usually includes a maximum length of the cord.

Field assembled extension cords which are made with listed components can use 16 AWG and larger wire on 20 ampere branch circuits.

For overcurrent devices rated 800 amps or less, section 240.4(B)(1-3) gives permission to use the next higher standard size overcurrent protective device when the conductor ampacity does not correspond with the standard rating of overcurrent protective devices listed in Table 240.6(A).

Question 19: The overcurrent protection for flexible cords, cables, and fixture wires:

A: Is determined from Table 310.15(B)(16).
B: Is required to be greater than the branch circuit that supplies them.
C: Can be provided by supplementary overcurrent protection.
D: Is required to be the same rating as the branch circuit.

## Question 20: 240.6 Standard Ampere Ratings.

Question ID#: 11343.0


***The trip time of an inverse time circuit breaker decreases as the fault current increases.***

There are two basic types of molded case circuit breakers:

***Instantaneous trip circuit breaker:*** The trip time for an instantaneous trip circuit breaker is the same for all levels of overcurrent. Instantaneous trip circuit breakers are also referred to as magnetic-only circuit breakers. Instantaneous circuit breakers are intended only for use as part of a listed combination motor controller.

***Inverse time circuit breaker:*** An inverse time circuit breaker trips in less time at higher levels of overcurrent than at lower levels of overcurrent. Inverse time circuit breakers have both thermal and magnetic tripping functions.

Table 240.6 gives the standard rating for fuses and inverse time circuit breakers. The standard ampere ratings for fuses and inverse time circuit breakers are: 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, and 6000 amperes. Additional standard ampere ratings for fuses are 1, 3, 6, 10, and 601.

If an adjustable-trip circuit breaker has an accessible external means to change the setting, the maximum possible setting is considered the ampere rating of the breaker. If the trip setting on an adjustable-trip breaker is protected by a removable and sealable cover over the adjusting screw, or if the equipment enclosure door is bolted shut, or if the breaker is behind locked doors which are only accessible to qualified personnel, then the rating of the breaker is permitted to be considered equal to the adjusted trip setting.

For overcurrent devices rated 800 amps or less, section 240.4(B)(1-3) gives permission to use the next higher standard size overcurrent protective device when the conductor ampacity does not correspond with the standard rating of overcurrent protective devices listed in 240.6(A).

Question 20: Two 500 kcmil conductors in parallel can carry 760 amps. The maximum rating of the standard overcurrent device protecting these conductors is:

A: 750 amps.
B: 400 amps.
C: 1000 amps.
D: 800 amps.

## Question 21: 240.6 Standard Ampere Ratings.

Question ID#: 11343.1

There are two basic types of molded case circuit breakers:

***The trip time of an inverse time circuit breaker decreases as the fault current increases.***

***Instantaneous trip circuit breaker:*** The trip time for an instantaneous trip circuit breaker is the same for all levels of overcurrent. Instantaneous trip circuit breakers are also referred to as magnetic-only circuit breakers. Instantaneous circuit breakers are intended only for use as part of a listed combination motor controller.

***Inverse time circuit breaker:*** An inverse time circuit breaker trips in less time at higher levels of overcurrent than at lower levels of overcurrent. Inverse time circuit breakers have both thermal and magnetic tripping functions.

Table 240.6 gives the standard rating for fuses and inverse time circuit breakers. The standard ampere ratings for fuses and inverse time circuit breakers are: 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, and 6000 amperes. Additional standard ampere ratings for fuses are 1, 3, 6, 10, and 601.

If an adjustable-trip circuit breaker has an accessible external means to change the setting, the maximum possible setting is considered the ampere rating of the breaker. If the trip setting on an adjustable-trip breaker is protected by a removable and sealable cover over the adjusting screw, or if the equipment enclosure door is bolted shut, or if the breaker is behind locked doors which are only accessible to qualified personnel, then the rating of the breaker is permitted to be considered equal to the adjusted trip setting.

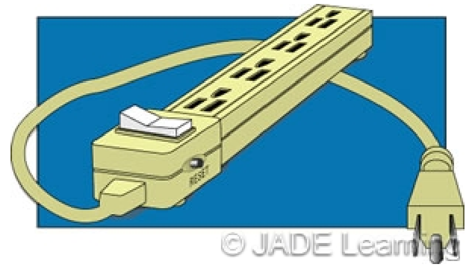
For overcurrent devices rated 800 amps or less, section 240.4(B)(1-3) gives permission to use the next higher standard size overcurrent protective device when the conductor ampacity does not correspond with the standard rating of overcurrent protective devices listed in 240.6(A).

Question 21: The ampacity of a 350-kcmil conductor is 310-amps. What is the maximum rating for a standard overcurrent protective device (OCPD) for two of these conductors connected in parallel?

A: 700-amps.
B: 310-amps.
C: 400-amps.
D: 620-amps.

## Question 22:   240.10  Supplementary Overcurrent Protection.

Question ID#: 11344.1



***Supplementary overcurrent protection, like that used in power strips, cannot be a substitute for branch circuit overcurrent protection.***

Some equipment has built-in overcurrent protection in addition to the branch circuit fuse or circuit breaker.  This additional overcurrent protection is usually installed by the manufacturer and is meant to protect the individual luminaire, appliance, or piece of equipment.  Much of the electronic equipment in use today has some form of protection for its internal circuitry.  The purpose of supplementary overcurrent protection is to protect and extend the life of the manufacturer's equipment.

Section 240.10 says this supplementary overcurrent protection cannot be a substitute for the branch circuit protection required by Articles 210 or 240.  This makes sense because there may be additional appliances or devices on the branch circuit which do not have supplementary overcurrent protection.  Even if each type of equipment on the branch circuit had supplementary overcurrent protection, the conductors connecting the equipment must be protected by the branch circuit fuse or breaker.

Because supplementary overcurrent protection is not the same thing as branch circuit overcurrent protection, supplementary overcurrent protection is not required to be readily accessible.  It can be behind locked or bolted covers, or installed in such a way as to not be easily replaced.

Question  22:   Which of the following statements about supplementary overcurrent protection is not correct?

A: Supplementary overcurrent protection is permitted for luminaries.
B: Supplementary overcurrent protection is required to be installed so that tools are required to access the overcurrent device(s).
C: Supplementary overcurrent protection is permitted for appliances.
D: Supplementary overcurrent protection is permitted for protection of internal components of equipment.

## Question 23:   240.13  Ground-Fault Protection of Equipment.

Question ID#: 11345.0


***Main disconnects rated 1000 amps or more must have ground fault protection for equipment for solidly grounded 277/480 volt systems.***

Each building or structure's main disconnecting means rated 1000 amps or more must have ground-fault protection for equipment if the equipment is supplied by a solidly grounded 3-phase, 4-wire, wye system with a voltage rating more than 150 volts to ground, but not more than 1000 volts phase-to-phase. A 480/277 volt wye connected system is a common example.

Ground-fault protection of equipment is similar to ground-fault protection for personnel in that it will shut the system down if there is leakage current to ground or a ground-fault. The difference is the trip point is higher in ground-fault protection of equipment (GFPE) than it is in ground-fault circuit interrupter protection for personnel (GFCI). GFPE is intended to protect equipment, not people.

There is also a requirement in 230.95 that 3-phase, 4-wire, wye building service disconnects rated 1000 amps or more must have ground-fault protection for equipment if the voltage rating is more than 150 volts to ground, but not more than 1000 volts phase-to-phase.  The requirement in 240.13 for 1000-amp ground-fault protection applies to buildings that are supplied by feeders or branch circuits, not services.

GFPE is not required for fire pumps and continuous industrial processes. Fire pumps supplying the sprinkler system must run as long as possible even with a ground-fault.  Continuous industrial processes do not require ground-fault protection if interrupting the process would present more of a hazard than starting an orderly shutdown.

Building disconnects rated 1000 amps or more are safer with ground-fault protection for equipment.  If a ground-fault develops into a phase-to-phase fault, or even if a ground-fault is not immediately taken offline, the disconnecting device is subject to severe damage which could cause fires or threaten the safety of personnel.

Question 23: For 480/277 volt solidly grounded wye system, ground-fault protection of equipment is required ______.

A: For fire pumps and continuous industrial processes.
B: For building main disconnects rated 1000 amps or more.
C: For building main disconnects rated 800 amps or more.
D: For buildings supplied by outside transformers.

## Question 24: 240.13 Ground-Fault Protection of Equipment.

Question ID#: 11345.1


***Main disconnects rated 1000 amps or more must have ground fault protection for equipment for solidly grounded 277/480 volt systems.***

Each building or structure's main disconnecting means rated 1000 amps or more must have ground-fault protection for equipment if the equipment is supplied by a solidly grounded 3-phase, 4-wire, wye system with a voltage rating more than 150 volts to ground, but not more than 1000 volts phase-to-phase. A 480/277 volt wye connected system is a common example.

Ground-fault protection of equipment is similar to ground-fault protection for personnel in that it will shut the system down if there is leakage current to ground or a ground-fault. The difference is the trip point is higher in ground-fault protection of equipment (GFPE) than it is in ground-fault circuit interrupter protection for personnel (GFCI). GFPE is intended to protect equipment, not people.

There is also a requirement in 230.95 that 3-phase, 4-wire, wye building service disconnects rated 1000 amps or more must have ground-fault protection for equipment if the voltage rating is more than 150 volts to ground, but not more than 1000 volts phase-to-phase. The requirement in 240.13 for 1000-amp ground-fault protection applies to buildings that are supplied by feeders or branch circuits, not services.

GFPE is not required for fire pumps and continuous industrial processes. Fire pumps supplying the sprinkler system must run as long as possible even with a ground-fault. Continuous industrial processes do not require ground-fault protection if interrupting the process would present more of a hazard than starting an orderly shutdown.

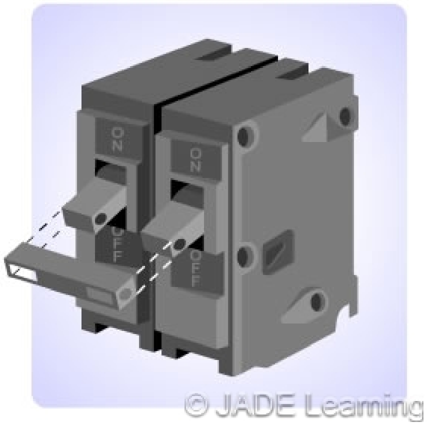
Building disconnects rated 1000 amps or more are safer with ground-fault protection for equipment. If a ground-fault develops into a phase-to-phase fault, or even if a ground-fault is not immediately taken offline, the disconnecting device is subject to severe damage which could cause fires or threaten the safety of personnel.

Question 24: Unless excluded by 240.13(1-3), which of the following 3-phase, 4-wire services is required to be provided with Ground-Fault Protection of Equipment?

A: A solidly grounded wye connected system rated at 800 amps that operates at 277/480-V.
B: A solidly grounded wye connected system rated at 1200 amps that operates at 277/480-V.
C: A wye connected system with an impedance grounded neutral rated at 1200-amps operated at 277/480-V.
D: A 240/480-V system rated at 1500-amps that is supplied by a solidly grounded delta transformer.

## Question 25: 240.15 (A)&(B) Ungrounded Conductors.

Question ID#: 11346.1




***Each ungrounded conductor in a circuit requires overcurrent protection. Two single pole circuit breakers with identified handle ties can protect line-to-line loads.***

Circuit breakers or fuses must be connected in series with each ungrounded conductor. A combination current transformer and overcurrent relay are considered the same as an overcurrent trip unit.

Section 210.4(B) requires the disconnecting means for multiwire branch circuits to simultaneously disconnect all ungrounded conductors at the point where the multiwire branch circuit originates.

In single-phase grounded systems, a 2-pole breaker or two single-pole breakers with identified handle ties are required to protect line-to-line loads.

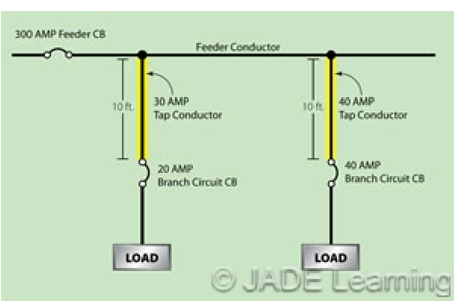
In 4-wire, 3-phase grounded systems, a 3-pole breaker or three single-pole breakers with identified handle ties are required for 3-phase loads.

Question 25: Which of the following statements about circuit breakers used to supply a 120/240-V multi-wire branch circuit for 120-V lighting loads in a commercial location is correct?

A: Two individual single-pole circuit breakers with identified handle ties are permitted to be connected to the same ungrounded bus.
B: Two individual single-pole circuit breakers without handle ties are permitted.
C: A double-pole circuit breaker is required to protect the circuit.
D: Two individual single-pole circuit breakers with identified handle ties or a double-pole circuit breaker are permitted.

## Question 26: 240.21(B)(1) Feeder Taps. Taps Not Over 10 ft. Long.

Question ID#: 11347.0




***Special rules apply to feeder tap conductors. A feeder tap conductor is protected at an ampacity greater than its rating.***

A general statement in 240.21 says overcurrent protection must be provided in each ungrounded conductor at the point where the conductor receives its supply. Tap conductors are an exception to this rule in that they are conductors which have overcurrent protection that exceeds the value of the conductor.

A tap conductor cannot be tapped to supply another tap conductor (tap a tap). The overcurrent device at the termination of the tap cannot be larger than the ampacity of the wire. In other words, the next higher standard size fuse cannot be selected.

Because the tap conductors do not have proper overcurrent protection they are a lot more dangerous than branch circuit conductors. The Code is very strict about the length of tap conductors because without proper overcurrent protection the conductor could be damaged. The longer the tap, the bigger the tap conductor must be.

If the tap is 10 ft. or less, the ampacity of the tap conductors must be (a) not less than the combined calculated loads on the circuits supplied by the tap conductors and (b) not less than the rating of the equipment containing an overcurrent device(s) supplied by the tap conductors or not less than the rating of the overcurrent protective device at the termination of the tap conductors. However, an exception permits tap conductors for specific listed devices like surge suppressors to be sized in accordance with manufacturer's instructions. For field installations, the ampacity of the tap conductors must not be less than 1/10 the rating of the overcurrent device protecting the feeders. For example, if a feeder is protected by a 300-amp circuit breaker, the minimum ampacity of a tap conductor is 30 amps.

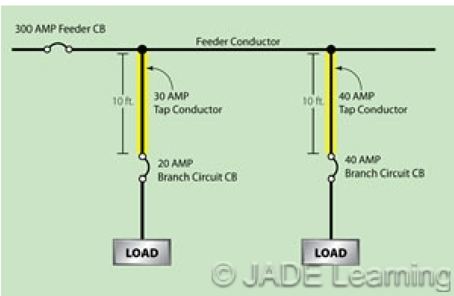
These general rules for 10 foot tap conductors make good common sense: (1) the tap conductors will see the combined loads from any equipment which is connected to the taps, so they must be big enough to handle the load. (2) If the tap ends in an overcurrent device which is the beginning of a branch circuit, all of the current on the branch circuit wires will flow on the tap conductors as well.

Question 26: A feeder is protected at 400 amps. An 8 ft. tap is made to the feeder to supply a 40 amp overcurrent protective device which is located outside the enclosure where the tap is made. What is the minimum ampacity of the tap conductor?

A: 100 amps.
B: 30 amps.
C: 40 amps.
D: 400 amps.

## Question 27: 240.21(B)(1) Feeder Taps. Taps Not Over 10 ft. Long.

Question ID#: 11347.1




***Special rules apply to feeder tap conductors. A feeder tap conductor is protected at an ampacity greater than its rating.***

A general statement in 240.21 says overcurrent protection must be provided in each ungrounded conductor at the point where the conductor receives its supply. Tap conductors are an exception to this rule in that they are conductors which have overcurrent protection that exceeds the value of the conductor.

A tap conductor cannot be tapped to supply another tap conductor (tap a tap). The overcurrent device at the termination of the tap cannot be larger than the ampacity of the wire. In other words, the next higher standard size fuse cannot be selected.

Because the tap conductors do not have proper overcurrent protection they are a lot more dangerous than branch circuit conductors. The Code is very strict about the length of tap conductors because without proper overcurrent protection the conductor could be damaged. The longer the tap, the bigger the tap conductor must be.

If the tap is 10 ft. or less, the ampacity of the tap conductors must be (a) not less than the combined calculated loads on the circuits supplied by the tap conductors and (b) not less than the rating of the equipment containing an overcurrent device(s) supplied by the tap conductors or not less than the rating of the overcurrent protective device at the termination of the tap conductors. However, an exception permits tap conductors for specific listed devices like surge suppressors to be sized in accordance with manufacturer's instructions. For field installations, the ampacity of the tap conductors must not be less than 1/10 the rating of the overcurrent device protecting the feeders. For example, if a feeder is protected by a 300-amp circuit breaker, the minimum ampacity of a tap conductor is 30 amps.

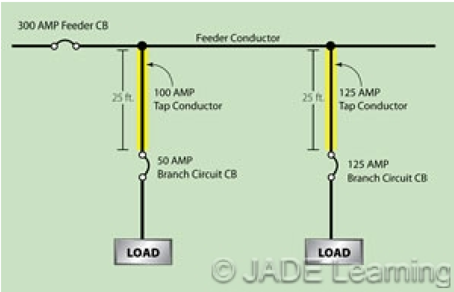
These general rules for 10 foot tap conductors make good common sense: (1) the tap conductors will see the combined loads from any equipment which is connected to the taps, so they must be big enough to handle the load. (2) If the tap ends in an overcurrent device which is the beginning of a branch circuit, all of the current on the branch circuit wires will flow on the tap conductors as well.

Question 27: What is the minimum ampacity for a 10 ft. feeder tap that terminates in a 15 amp overcurrent device, and is tapped from a 200 amp feeder?

A: 20-amps.
B: 25-amps.
C: 15-amps.
D: 30-amps.

## Question 28: 240.21(B)(2) Feeder Taps. Taps Not over 25 ft. Long.

Question ID#: 11348.0




***For the same load, a 25 ft. feeder tap must use larger wire than a 10 ft. feeder tap.***

As the taps get longer the minimum size of the tap conductor gets larger. For a 10 ft. tap the ampacity of the tap conductor must be at least 1/10 the rating of the feeder overcurrent device. For taps up to 25 ft. the ampacity of the tap conductor must be at least 1/3 the rating of the feeder overcurrent device. More can go wrong on a longer tap, so it must be capable of carrying more current. In addition, a tap up to 25 ft. must be protected from physical damage or enclosed in a raceway and terminate in a single circuit breaker or set of fuses that will limit the load to the ampacity of the tap conductors.

***Example No. 1.*** A 25 ft. tap is connected to a feeder which is protected at 300 amps. The feeder tap terminates at a 50 amp circuit breaker. A 50 amp conductor is adequate to serve the load, but because the tap is 25 ft. long the ampacity of the tap conductors must be at least 1/3 the rating of the feeder overcurrent device, or 100 amps. (300 amps/3 = 100 amps). See the illustration.

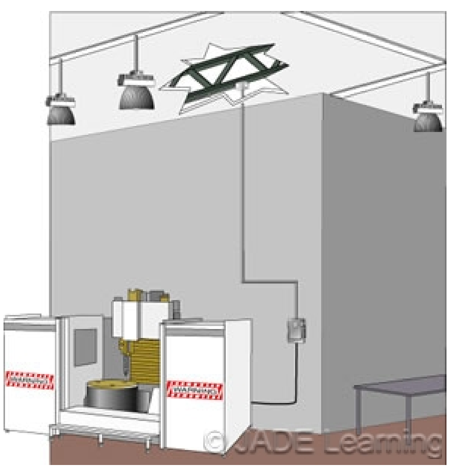
***Example No. 2.*** A 25 ft. tap is connected to a feeder which is protected at 150 amps. The feeder tap terminates at a 20 amp fuse, but the tap conductors must not be rated less than 1/3rd the rating of the feeder overcurrent device. The minimum ampacity of the tap conductor is 50 amps. (150 amps/3 = 50 amps).

Question 28: A feeder is protected by a 200 amp fuse. A tap conductor is 22 ft. long and terminates in a 40 amp circuit breaker. What is the minimum ampacity of the tap conductor?

A: 200 amps.
B: 40 amps.
C: 67 amps.
D: 63 amps.

## Question 29: 240.21(B)(4)&(5) Feeder Taps. Taps Over 25 ft. Long & Outside Taps.

Question ID#: 11349.1




***Feeder taps longer than 25 ft., such as in a high bay manufacturing building, are permitted, but must meet many conditions.***

In high bay manufacturing buildings if a tap is made in the ceiling it is often more than 25 ft. down the wall to the equipment. Taps over 25 ft. long are permitted in high bay manufacturing facilities to allow for longer tap conductor runs.

As usual, though, there are a number of conditions:

- Only qualified people may service the system.
- The tap conductors are not over 25 ft. long horizontally and not over 100 ft. total length.
- The tap conductors must be rated at least 1/3 the ampacity of the feeder OCPD.
- The tap conductors terminate in a single circuit breaker or a single set of fuses.
- The tap conductors are protected from physical damage.
- The tap conductors are continuous from end to end without splices.
- The tap conductors are minimum size 6 AWG copper or 4 AWG aluminum.
- The tap conductors do not penetrate walls, floors or ceilings.
- The tap is made no less than 30 ft. from the floor.

Question 29: In a 35-foot high-bay manufacturing facility the total length of a tap conductor is limited to a maximum of ________ feet.

A: 100 feet.
B: 50 feet horizontal and 50-feet vertical.
C: 35 feet vertical & 25-feet horizontal.

D: 35 feet.

## Question 30: 240.21(C)(1)(2)&(3) Transformer Secondary Conductors.

Question ID#: 11350.0


***Overcurrent protection on the secondary side of a transformer can be omitted if the tap conductor on the secondary side of the transformer meets all the conditions in this section.***

Transformer secondary conductors can be installed without overcurrent protection at the secondary of the transformer if the conditions of 240.21(C) are met. Six different options are provided (240.21(C)(1) - (C)(6)).

Conductors on the secondary side of a 2-wire single-phase transformer or on the secondary side of a 3-wire (single voltage) delta-delta connected 3-phase transformer are permitted to be protected by the primary overcurrent protection if the conditions in (C)(1) are met. Secondary protection for other transformer installations must be provided in accordance with one of the options provided by (C)(2) through (C)(6).

Overcurrent protection at the secondary of a transformer can be omitted if the secondary conductors are not longer than 10 feet ***and*** all of the following conditions are met:

- The ampacity of the secondary conductors is not less than:
a. The total calculated load on the secondary conductors.
b. The rating of the overcurrent device provided with the equipment being supplied by the secondary conductors or the rating of the overcurrent device at the termination of the secondary conductors.
- The secondary conductors do not extend beyond the equipment that they supply.
- The secondary conductors are enclosed by a raceway from the transformer to the equipment they supply.
- The rating of the primary overcurrent protective device multiplied by the ratio of the primary to secondary voltage shall not exceed 10 times the ampacity of the secondary conductors. (See example.)

Example:

Given a 100kVA, 3-phase transformer with a primary to secondary voltage of 480V to 208Y/120V and 150-A overcurrent protection on the primary side only, what is the minimum ampacity and size of the secondary conductors less than 10 feet long?

The primary OCPD is 150-A and the primary to secondary voltage ratio is 2.31 (480/208), 150 x 2.31 = 346.5. To find the minimum ampacity of the conductor, divide 346.5 by 10, 346.5/10 = 34.7 amps. This is equivalent to multiplying the minimum allowable conductor ampacity by 10.

The minimum secondary conductor ampacity is 34.7 amps, or 35 amps.

According to Table 310.15(B)(16), the smallest conductor with a rated ampacity of more than 35 amps at 60Â°C, is a No. 8 AWG copper conductor.

In industrial installations where maintenance and supervision ensure that only qualified persons service the switchgear and switchboards, overcurrent protection is not required at the secondary for supply conductors 25 feet or less if: the ampacity of the secondary conductors is greater than the transformer's secondary current rating, the sum of the ratings of all the overcurrent protection devices does not exceed the ampacity of the secondary conductors and all overcurrent protection devices are grouped. The conductors must also be protected using an approved raceway or other approved method.

Question 30: Transformer secondary conductors are not over 10 ft. long and are installed in a raceway without overcurrent protection to a disconnect with 200 amp fuses. The disconnect will supply a 175 amp load. Which of the following is a true statement?

A: Transformer secondary conductors must be protected at the transformer.
B: The installation as described is a Code violation.
C: The secondary conductors must be rated at least 200 amps.
D: The secondary conductors must be rated at least 175 amps.

## Question 31: 240.21(C)(1)(2)&(3) Transformer Secondary Conductors.

Question ID#: 11350.1


***Overcurrent protection on the secondary side of a transformer can be omitted if the tap conductor on the secondary side of the transformer meets all the conditions in this section.***

Transformer secondary conductors can be installed without overcurrent protection at the secondary of the transformer if the conditions of 240.21(C) are met. Six different options are provided (240.21(C)(1) - (C)(6)).

Conductors on the secondary side of a 2-wire single-phase transformer or on the secondary side of a 3-wire (single voltage) delta-delta connected 3-phase transformer are permitted to be protected by the primary overcurrent protection if the conditions in (C)(1) are met. Secondary protection for other transformer installations must be provided in accordance with one of the options provided by (C)(2) through (C)(6).

Overcurrent protection at the secondary of a transformer can be omitted if the secondary conductors are not longer than 10 feet ***and*** all of the following conditions are met:

- The ampacity of the secondary conductors is not less than:
a. The total calculated load on the secondary conductors.
b. The rating of the overcurrent device provided with the equipment being supplied by the secondary conductors or the rating of the overcurrent device at the termination of the secondary conductors.
- The secondary conductors do not extend beyond the equipment that they supply.
- The secondary conductors are enclosed by a raceway from the transformer to the equipment they supply.
- The rating of the primary overcurrent protective device multiplied by the ratio of the primary to secondary voltage shall not exceed 10 times the ampacity of the secondary conductors. (See example.)

Example:

Given a 100kVA, 3-phase transformer with a primary to secondary voltage of 480V to 208Y/120V and 150-A overcurrent protection on the primary side only, what is the minimum ampacity and size of the secondary conductors less than 10 feet long?

The primary OCPD is 150-A and the primary to secondary voltage ratio is 2.31 (480/208), 150 x 2.31 = 346.5. To find the minimum ampacity of the conductor, divide 346.5 by 10, 346.5/10 = 34.7 amps. This is equivalent to multiplying the minimum allowable conductor ampacity by 10.

The minimum secondary conductor ampacity is 34.7 amps, or 35 amps.

According to Table 310.15(B)(16), the smallest conductor with a rated ampacity of more than 35 amps at 60Â°C, is a No. 8 AWG copper conductor.

In industrial installations where maintenance and supervision ensure that only qualified persons service the switchgear and switchboards, overcurrent protection is not required at the secondary for supply conductors 25 feet or less if: the ampacity of the secondary conductors is greater than the transformer's secondary current rating, the sum of the ratings of all the overcurrent protection devices does not exceed the ampacity of the secondary conductors and all overcurrent protection devices are grouped. The conductors must also be protected using an approved raceway or other approved method.

Question 31: A single-phase transformerâ€™s secondary conductors are 7.5 feet long and are installed in RMC and are terminated in panelboard on a 150 amp circuit breaker that is the panelboardâ€™s main disconnect.
If no secondary overcurrent protection is installed for the transformer, which of the following statements about the installation is correct?

A: Transformer secondary conductors must be protected at the transformer.
B: The minimum ampacity of the ungrounded secondary transformer conductors is 150 amps.
C: The installation as described is a Code violation.
D: The minimum ampacity of the ungrounded secondary transformer conductors is 175 amps.

## Question 32: 240.21(C)(4)&(6) Outside Transformer Secondary Conductors and Transformer Secondary Conductors Not Over 25 ft. Long.

Question ID#: 11351.0

Outside transformer secondary conductors covered by 240.21(C)(4) can be installed without overcurrent protection at the secondary of the transformer if the four conditions listed in (C)(4) are met. There is no length restriction for the conductors if they remain outside of a building or structure.


***The requirements for outdoor transformer taps are not as strict as for transformer taps inside a building.***

The outside secondary conductors must be protected from physical damage and must terminate at a single circuit breaker or set of fuses that limit the load to the ampacity of the conductors. The disconnecting means at the termination of the secondary conductors must be installed in a readily accessible location either outside of the building served or inside nearest the point of entrance of the conductors into the building.

Section 240.21(C)(6) permits indoor transformer secondary conductors to be installed in lengths up to 25 feet in most conditions that are typical in commercial work. The conductors must be protected from physical damage and terminate in a single circuit breaker or set of fuses which limit the current to the ampacity of the secondary conductors.

Additionally, the ampacity of indoor secondary conductors shall not be less than the value determined by multiplying the primary to secondary transformer voltage ratio by 1/3 the rating of the transformer primary overcurrent device.

Example:

A transformer with a 480 volt primary and 208 volt secondary has a primary to secondary voltage ratio of 480/208 = 2.3. If the primary side overcurrent protection is rated 150 amps, multiply the voltage ratio of 2.3 by 1/3 of 150 amps to determine the minimum allowable ampacity for the secondary conductors. (2.3 X 50 = 115 amps).

Question 32: Which of the following statements is true?

A: Outside transformer secondary conductors are limited to 100 ft. in length.
B: Outdoor transformer secondary conductors must terminate in a disconnecting means located outside the building.
C: Indoor transformer secondary conductors not over 25 ft. long must terminate in an overcurrent device which limits the load current to the ampacity of the conductors.
D: Indoor transformer secondary conductors not over 125 ft. long cannot be smaller than 1/4 the rating of the transformer primary overcurrent device.

## Question 33: 240.21(C)(4)&(6) Outside Transformer Secondary Conductors and Transformer Secondary Conductors Not Over 25 ft. Long.

Question ID#: 11351.1


***The requirements for outdoor transformer taps are not as strict as for transformer taps inside a building.***

Outside transformer secondary conductors covered by 240.21(C)(4) can be installed without overcurrent protection at the secondary of the transformer if the four conditions listed in (C)(4) are met. There is no length restriction for the conductors if they remain outside of a building or structure.

The outside secondary conductors must be protected from physical damage and must terminate at a single circuit breaker or set of fuses that limit the load to the ampacity of the conductors. The disconnecting means at the termination of the secondary conductors must be installed in a readily accessible location either outside of the building served or inside nearest the point of entrance of the conductors into the building.

Section 240.21(C)(6) permits indoor transformer secondary conductors to be installed in lengths up to 25 feet in most conditions that are typical in commercial work. The conductors must be protected from physical damage and terminate in a single circuit breaker or set of fuses which limit the current to the ampacity of the secondary conductors.

Additionally, the ampacity of indoor secondary conductors shall not be less than the value determined by multiplying the primary to secondary transformer voltage ratio by 1/3 the rating of the transformer primary overcurrent device.

Example:

A transformer with a 480 volt primary and 208 volt secondary has a primary to secondary voltage ratio of 480/208 = 2.3. If the primary side overcurrent protection is rated 150 amps, multiply the voltage ratio of 2.3 by 1/3 of 150 amps to determine the minimum allowable ampacity for the secondary conductors. (2.3 X 50 = 115 amps).

Question 33: A single-phase transformer with a 480 volt primary and a 240 volt secondary has secondary conductors 22 feet long installed in RMC. The secondary conductors are terminated on a circuit-breaker that limits the conductor ampacity to the conductorâ€™s rated ampacity.
What is the minimum ampacity of the secondary transformer conductors if the transformer primary is protected by a 150-amp circuit-breaker?

A: 200 amps.
B: 100 amps.
C: 250 amps.
D: 150 amps.

## Question 34: 240.22 Grounded Conductor.

Question ID#: 11352.0

Overcurrent devices are not permitted to be installed in series with grounded conductors unless (1) the overcurrent device opens all conductors of the circuit, including the grounded conductor, and is designed so that no pole can operate independently, or (2) where required by 430.36 or 430.37 for motor overload protection.


***Overcurrent protection is not installed in series with the grounded neutral conductor unless it disconnects the ungrounded conductors as well.***

Fusing a grounded conductor is dangerous because if the fuse in the grounded conductor blows, no current will flow in the circuit and the equipment will not operate, but if the ungrounded conductors are still connected to the load they remain energized and pose a serious shock hazard.

Wiring to a gasoline dispensing pump has a similar requirement to disconnect the grounded and ungrounded conductors. All the conductors to the pump must be disconnected at the same time, including the grounded conductor. If the grounded (neutral) and the ungrounded conductors are disconnected from the pump there is no possibility of any current returning through the neutral and causing a spark.

Overcurrent protection can be placed in the grounded conductor when used for motor overload protection (430.36 & 430.37). However, the only time this is allowed is when the supply circuit is a 3-wire, 3-phase system and one of the phase wires is grounded, like in a corner grounded 3-phase delta system.

Question 34: Installing an overcurrent device in the grounded conductor:

A: Is permitted if the device opens all conductors of the circuit.
B: Is a common practice for motor overload protection.
C: Is not permitted in service station wiring.
D: Is not allowed under any circumstances.

## Question 35: 240.22 Grounded Conductor.

Question ID#: 11352.1

Overcurrent devices are not permitted to be installed in series with grounded conductors unless (1) the overcurrent device opens all conductors of the circuit, including the grounded conductor, and is designed so that no pole can operate independently, or (2) where required by 430.36 or 430.37 for motor overload protection.


***Overcurrent protection is not installed in series with the grounded neutral conductor unless it disconnects the ungrounded conductors as well.***

Fusing a grounded conductor is dangerous because if the fuse in the grounded conductor blows, no current will flow in the circuit and the equipment will not operate, but if the ungrounded conductors are still connected to the load they remain energized and pose a serious shock hazard.

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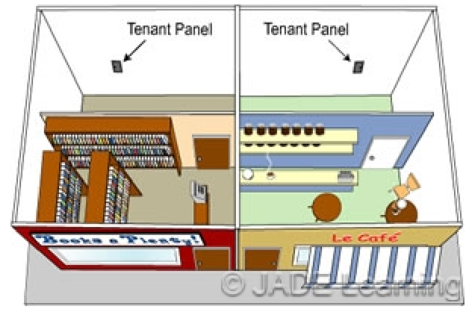
Overcurrent protection can be placed in the grounded conductor when used for motor overload protection (430.36 & 430.37). However, the only time this is allowed is when the supply circuit is a 3-wire, 3-phase system and one of the phase wires is grounded, like in a corner grounded 3-phase delta system.

Question 35: Fuses used as motor overload protective devices are permitted to be installed in series with grounded conductors in which of the following circuits?

A: A 2-wire 120-V motor circuit supplied by a 208/120-V, 4-wire wye-connected solidly grounded system.
B: A 3-wire, 3-phase 240-V circuit supplied by a 4-wire, 480/240-V, 4-wire, wye connected solidly grounded system.
C: A 3-wire, 3-phase 480-V circuit supplied by a 3-phase, 3-wire corner grounded Delta system.
D: A 2-wire 480-V motor circuit supplied by a 480/277-V, 4-wire wye-connected solidly grounded system.

## Question 36: 240.24 Location of Overcurrent Devices on the Premises.

Question ID#: 11353.0




***Each building occupant must have access to the overcurrent devices protecting their space.***

Switches containing fuses and circuit breakers must be readily accessible. Readily accessible means the overcurrent devices can be reached quickly for operation. The definition of readily accessible in Article 100 does not permit the use of a tool other than a key to access equipment that is required to be readily accessible. However, a new exception permits the use of a tool such as a screwdriver or wrench to access overcurrent devices within listed industrial control panels and similar enclosures.

Where switches contain fuses or circuit breakers the center of the operating handle grip must not be higher than 6 feet 7 inches above the floor or working platform when in its highest position. The readily accessible requirement does not apply to switches mounted on busways, supplementary overcurrent protection, feeder overcurrent protection installed in accordance with 225.40, service overcurrent protection installed per 230.92 and disconnect switches located adjacent to utilization equipment.

For example, a portable ladder is often required to access overcurrent devices located next to the utilization equipment they supply. A fused disconnect for an air handler located above a suspended ceiling is not readily accessible if a portable ladder is required to access it, but is still acceptable because it serves as the disconnecting means adjacent to the air handler.

Specific rules apply to the location of overcurrent devices in multi-occupancy buildings. If electrical maintenance is provided by the building management, the feeder and service overcurrent devices can be accessible only to authorized maintenance personnel. Except for hotels and motels, the branch circuit breakers supplying each individual space must be located so the occupant can easily get to them. In hotels and motels the branch circuit breakers supplying guest rooms are permitted to be accessible to authorized management personnel only unless permanent provisions for cooking are provided in the guest room.

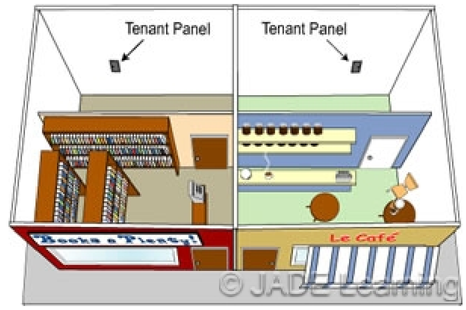
There are some locations where overcurrent devices must not be installed. Overcurrent devices cannot be located where exposed to physical damage or located in bathrooms of dwelling units, dormitories, guest rooms or guest suites. Overcurrent devices are also prohibited in clothes closets or in other areas with easily ignitable material. Overcurrent devices are not permitted over the steps in a stairway, because the steps do not provide for sufficient working space in front of the electrical equipment.

Question 36: Which of the following is a Code violation?

A: A fusible disconnect switch installed so that the handle is 6 ft. 10 in. above the floor.
B: Feeder breakers for a tenant space accessible only to building management electrical maintenance personnel.
C: A fusible disconnect switch for an air compressor located on a walkway.
D: Circuit breakers in a panelboard located outside a bathroom.

## Question 37: 240.24 Location of Overcurrent Devices on the Premises.

Question ID#: 11353.1




***Each building occupant must have access to the overcurrent devices protecting their space.***

Switches containing fuses and circuit breakers must be readily accessible. Readily accessible means the overcurrent devices can be reached quickly for operation. The definition of readily accessible in Article 100 does not permit the use of a tool other than a key to access equipment that is required to be readily accessible. However, a new exception permits the use of a tool such as a screwdriver or wrench to access overcurrent devices within listed industrial control panels and similar enclosures.

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There are some locations where overcurrent devices must not be installed. Overcurrent devices cannot be located where exposed to physical damage or located in bathrooms of dwelling units, dormitories, guest rooms or guest suites. Overcurrent devices are also prohibited in clothes closets or in other areas with easily ignitable material. Overcurrent devices are not permitted over the steps in a stairway, because the steps do not provide for sufficient working space in front of the electrical equipment.

Question 37: In which of the following locations is a panelboard with overcurrent devices permitted to be installed?

A: In a clothes closet.
B: In a bathroom in an office complex.
C: In a bathroom of a dwelling unit.
D: In a bathroom in a college dormitory.

## Question 38: 240.30 Protection from Physical Damage. 240.33 Mounted in Vertical Position.

Question ID#: 11354.0

Overcurrent devices such as circuit breakers are protected from physical damage by being installed in enclosures, cabinets, cutout boxes, or equipment assemblies. Enclosures for overcurrent devices are generally mounted in the vertical (upright) position, however, they ***are*** permitted in the horizontal position if mounting the enclosure vertically is impracticable (impossible).


***Enclosures for overcurrent devices may be mounted in the horizontal position if mounting vertically is impracticable and the on position is the up position of the circuit breaker handle.***

If the enclosure is to be mounted in the horizontal (sideways) position, all circuit breakers must clearly indicate the ON and OFF positions for the circuit breaker handles. Where circuit breaker handles are operated vertically (up and down) rather than rotationally or horizontally (side to side), the "up" position of the handle must be the ON position.

Because Section 240.33 allows enclosures for overcurrent devices to be mounted in the horizontal position (sideways) when it is impracticable to mount them vertically, the enclosure may require that all circuit breakers be removed from one side of the enclosure. Typically the branch circuit breaker handles move inward toward each other as each side of the panel is flipped to the ON position. This would cause the top row of breakers to flip to the "down" position when turning the breakers ON, this is not permitted.

***Impracticable in the NEC***

Impracticable in the NEC means impossible. The authority having jurisdiction (AHJ) would have to agree that it is impracticable to mount the enclosure in the vertical position for the horizontal installation to be approved. The vertical space would have to be severely restricted and without other options for mounting the circuit breaker or fuse enclosure vertically, in order for this to be approved.

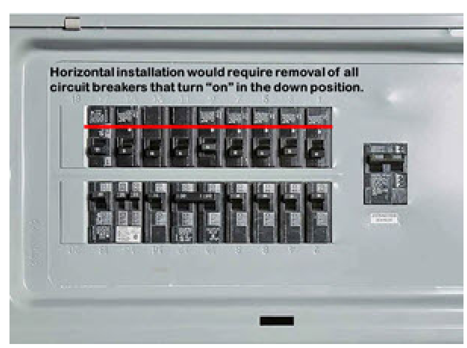
Question 38: Which of the following is a true statement?

A: Circuit breaker enclosures may never be mounted in the horizontal position.
B: Circuit breaker enclosures are always required to be mounted in a vertical position without exception.
C: Circuit breaker enclosures may be mounted in the horizontal position if it is not practicable to mount the enclosure in the vertical position and all the circuit breaker handles are up while in the ON position.
D: All circuit breaker enclosures are required to be mounted so that the circuit breaker handles operate vertically.

## Question 39: 240.30 Protection from Physical Damage. 240.33 Mounted in Vertical Position.

Question ID#: 11354.1

Overcurrent devices such as circuit breakers are protected from physical damage by being installed in enclosures, cabinets, cutout boxes, or equipment assemblies. Enclosures for overcurrent devices are generally mounted in the vertical (upright) position, however, they ***are*** permitted in the horizontal position if mounting the enclosure vertically is impracticable (impossible).




***Enclosures for overcurrent devices may be mounted in the horizontal position if mounting vertically is impracticable and the on position is the up position of the circuit breaker handle.***

If the enclosure is to be mounted in the horizontal (sideways) position, all circuit breakers must clearly indicate the ON and OFF positions for the circuit breaker handles. Where circuit breaker handles are operated vertically (up and down) rather than rotationally or horizontally (side to side), the "up" position of the handle must be the ON position.

Because Section 240.33 allows enclosures for overcurrent devices to be mounted in the horizontal position (sideways) when it is impracticable to mount them vertically, the enclosure may require that all circuit breakers be removed from one side of the enclosure. Typically the branch circuit breaker handles move inward toward each other as each side of the panel is flipped to the ON position. This would cause the top row of breakers to flip to the "down" position when turning the breakers ON, this is not permitted.

***Impracticable in the NEC***

Impracticable in the NEC means impossible. The authority having jurisdiction (AHJ) would have to agree that it is impracticable to mount the enclosure in the vertical position for the horizontal installation to be approved. The vertical space would have to be severely restricted and without other options for mounting the circuit breaker or fuse enclosure vertically, in order for this to be approved.

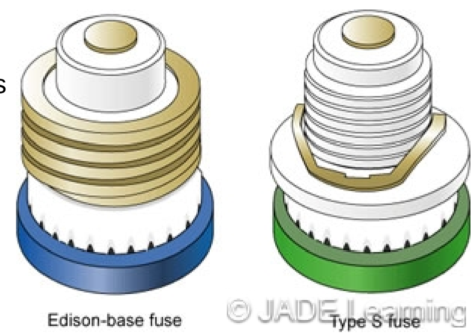
Question 39: Overcurrent devices are permitted to be installed in all of the following locations except:

A: In listed bus duct disconnects installed 15 feet above the floor.
B: In enclosures, cabinets & in cutout boxes.
C: Where unprotected from physical damage.
D: In listed equipment assemblies.

## Question 40: 240.50 & 240.54 Plug Fuses, Fuseholders, and Adapters.

Question ID#: 11355.0

Plug fuses are the old screw-in type fuses. There are two types of plug fuses: Edison-base and Type S. The Edison-base fuses have a larger diameter metallic base than the S-type which have a porcelain base. Edison-base fuses are dangerous because it is physically possible to replace lower rated fuses that have blown with higher rated fuses. Many house fires have been caused by homeowners replacing a blown 15 amp fuse with a 30 amp fuse. Edison-base fuses can only be used as replacements in existing installations. If additional Edison-base fuseholders are installed they must be fitted with S-Type adapters.




***Many older homes still use Edison-base or Type S plug fuses.***

Plug fuses are only permitted on the following circuits, (1) where the voltage between conductors is 125 volts or less or (2) circuits on systems with a grounded neutral point and the line-to-neutral voltage does not exceed 150 volts.

The screw shell of a plug-type fuseholder must be connected to the load side of the circuit.

Type S fuses are classified 0-15 amps, 16-20 amps, and 21-30 amps. A type S fuse of one classification is not interchangeable with a fuse of a lower classification. Type S fuses have narrow barrels and will only fit in a Type S fuseholder or a fuseholder with a Type S adapter. Once a Type S adapter has been installed in a fuseholder it cannot be removed.

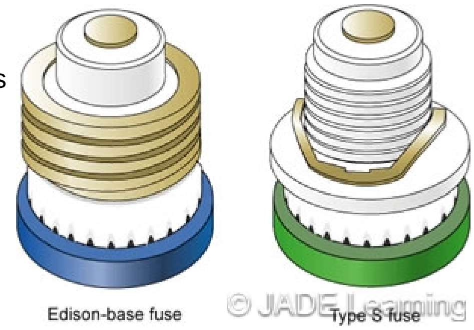
Note: The NEC has three different classifications of type S fuses. None of the type S classifications will interchange with any of the other classes.

Question 40: Why are Type S fuses safer than Edison-base fuses?

A: Edison-base fuses do not blow at their rated ampacities.
B: Type S fuses can be used only on line-to-neutral loads.
C: Type S fuses of a higher ampere rating will not fit a Type S holder with a lower ampere classification.
D: The screw shell of the Type S fuseholder is connected to the load side of the circuit.

## Question 41: 240.50 & 240.54 Plug Fuses, Fuseholders, and Adapters.

Question ID#: 11355.1




***Many older homes still use Edison-base or Type S plug fuses.***

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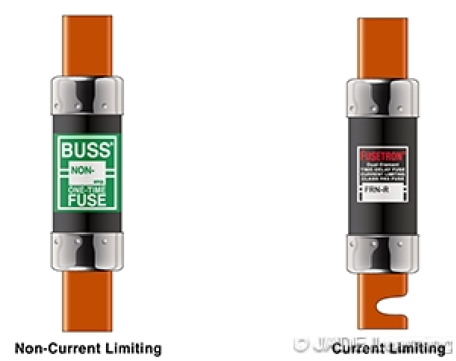
Note: The NEC has three different classifications of type S fuses. None of the type S classifications will interchange with any of the other classes.

Question 41: Which of the following installations of plug type fuses is a code violation?

A: Replacing a 15-amp Edison base fuse holder with a 15-amp type S fuseholder to protect a 120-V, general purpose lighting circuit in a dwelling.
B: Replacing a 20-amp Edison base fuse holder with a 20-amp type S fuseholder to protect a 120-V, 20-amp small-appliance circuit in a dwelling.
C: Replacing a 15-amp Edison base fuse holder with a 15-amp type S fuseholder to protect a 120-V circuit where is no evidence of tampering.
D: Replacing a 20-amp Edison base fuse holder with a 20-amp type S fuseholder to protect a 20-amp, single-phase 240-V well pump.

## Question 42: Part VI. 240.60(A-C) Cartridge Fuses and Fuseholders.

Question ID#: 11356.0




***Fuses are designed to work at different voltage and current levels. A current limiting fuse holder will only accept a current limiting fuse.***

Cartridge fuses are available in a wide range of sizes, ampere and voltage ratings up to 600 volts and 600 amperes. There are two basic types of cartridge fuses, general purpose fuses and heavy-duty fuses. General-purpose fuses have no time-delay and are typically used in non-motor applications. Heavy-duty fuses have time delay characteristics that allow for the momentary inrush of current when a motor starts.

Fuses are both marked and designed to be used in circuits that do not exceed their voltage or current ratings. Fuses and fuseholders are manufactured to prevent their being used for lower current or higher voltage applications.

The 300 volt type cartridge fuse is designed to be used in circuits where the voltage between any two ungrounded (energized) conductors is not more than 300 volts, and it is also permitted to be used in single-phase circuits supplied by a 3-phase, 4-wire, solidly grounded neutral system where the line-to-neutral voltage does not exceed 300 volts.

The longer 600 volt fuses will not fit into a 300 volt fuseholder, and the 300 volt type cartridge fuse will not fit into a 600 volt fuseholder. Fuses are also made with different diameter barrels, the diameter increases as the ampere classification rating increases. This is done to help prevent replacing a blown fuse with one of a higher ampere classification than the circuit was designed for.

Current-limiting fuses are fast-acting fuses that can clear a fault in less than half a cycle. Equipment downstream from the current-limiting fuse can have interrupting ratings equal to the let-through current of the current-limiting fuse. These downstream reduced interrupting ratings are usually less than the available fault current on the line side of the fuse.

If a current-limiting fuse must be replaced it is very important it is not replaced with a non-current limiting fuse. Non-current limiting fuses will allow the higher available fault current to be let through causing a catastrophic failure of the lower rated devices that were designed and protected using the current-limiting fuse. The fuseholders for current-limiting fuses are made with rejection features designed to prevent a non-current-limiting fuse from being installed in place of a current-limiting fuse. The rejection feature is usually a bar across the clips of the fuseholder or a slot in the clip that will accept a grooved ring on the ferrule of a current-limiting fuse.

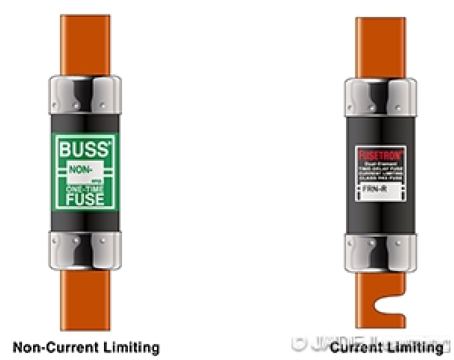
Current-limiting fuses can be used to replace non-current-limiting fuses because the rejection features are only designed to prevent the use of non-current-limiting fuses in place of current-limiting fuses. Non-current limiting fuses or fuseholders must never be used as replacements where current-limiting fuses are required.

Question 42: Which of the following statements is true?

A: A 300-volt type fuse cannot be used on a 277 volt single-phase circuit.
B: A current-limiting fuseholder will reject a non-current-limiting fuse.
C: A 600-volt type fuse could fit into a 300-volt type fuseholder.
D: A current-limiting fuse will not fit into a non-current-limiting fuseholder.

## Question 43: Part VI. 240.60(A-C) Cartridge Fuses and Fuseholders.

Question ID#: 11356.1



***Fuses are designed to work at different voltage and current levels. A current limiting fuse holder will only accept a current limiting fuse.***

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Current-limiting fuses can be used to replace non-current-limiting fuses because the rejection features are only designed to prevent the use of non-current-limiting fuses in place of current-limiting fuses. Non-current limiting fuses or fuseholders must never be used as replacements where current-limiting fuses are required.

Question 43: Which of the following is always required to be marked on all cartridge type fuses?

A: Interrupting rating.
B: Current Limiting.
C: Ampere rating.
D: Manufacturerâ€™s name.

## Question 44: 240.80 -- 240.83 Circuit Breakers.

Question ID#: 11357.0

Part VII of Article 240 gives the following requirements for circuit breakers:

- They must clearly indicate whether they are in the on or off position.
- The on position must be up; the off position must be down, with the exception of 240.33 (when mounted horizontally).
- The trip setting and time delay features must be tamperproof.
- The voltage and current rating must be clearly marked.
- If the interrupting rating (AIC) is other than 5000 amps it must be marked.
- They shall be trip free and capable of being opened and closed manually.


***This Code section contains rules for circuit breaker manufacturers and circuit breaker installers.***

In addition to the above general requirements, circuit breakers that are used as switches for some types of lighting circuits require special markings.

Because of the electrical characteristics of High Intensity Discharge (HID) lights, circuit breakers used as switches for circuits that supply HID lights have to be able to withstand significant arcing that occurs each time the circuits are opened. Breakers used as switches for HID lighting circuits are required to be marked HID. The most common types of HID lighting are listed below:

- Mercury-vapor lamps
- Metal-halide (MH) lamps
- Ceramic MH lamps
- Sodium-vapor lamps
- Xenon short-arc lamps

Circuit breakers used as switches for 120-volt and 277-volt fluorescent light circuits are required to be marked either SWD or HID. Fluorescent lights are ***not*** HID lights, but a circuit breaker that is marked HID is permitted to be used to control any load that an SWD circuit breaker can. Circuit breakers used as switches for fluorescent lights are ***not*** required to be marked HID if marked SWD. However, a breaker that is marked SWD cannot be used to control an HID load.

Note: SWD - switching duty HID- high intensity discharge

Question 44: When circuit breakers are used as switches:

A: They must be listed and marked SWD if used on high intensity discharge lighting circuits.
B: They must be listed and marked HID if used on fluorescent or high intensity discharge lighting circuits.
C: They must be listed and marked either SWD or HID if used on 120 VAC or 277 VAC fluorescent lighting circuits.
D: They must be listed and marked with both SWD and HID if used on fluorescent lighting circuits.

## Question 45: 240.85 Applications of Circuit Breakers.

Question ID#: 11358.0

If a circuit breaker has a straight voltage rating, such as 240 volts, it can be used in an AC system where the voltage between any two conductors is not greater than the single voltage rating of the circuit breaker. If a circuit breaker has a slash rating, like 120/240 volts, it can be used in an AC system where the voltage between phase conductors is not greater than the higher rating (240 volts), and the voltage to ground is not greater than the lower rating (120 volts).


***The voltage to ground on a circuit breaker with a slash rating cannot be more than the lower rating on the breaker.***

A circuit breaker with a 120/240 rating could be used on a 3-phase, 4-wire 120/208 volt system because the phase-to-phase voltage is less than 240 volts and the phase-to-ground voltage is 120 volts. A breaker with a 120/240 volt rating could not be used on a 277/480 volt system because both the system phase-to-phase and the phase-to-ground voltage are greater than the rating of the breaker.

In a 3-phase, 3 wire, corner grounded delta system, one of the phase legs is grounded. If the system voltage was 480 volts then the single-phase voltage between any one ungrounded conductor and the grounded leg would be 480 volts. A circuit breaker with a 277/480 volt rating could not be used on such a system because the voltage to ground is greater than 277 volts.

Question 45: A single-pole breaker is used on a 277/480 volt, 3-phase, 4-wire system. Which of the following ratings on the breaker could be used?

A: 120/208 volts.
B: 240 volts.
C: 120/240 volts.
D: 277/480 volts.

## Question 46: 240.85 Applications of Circuit Breakers.

Question ID#: 11358.1

If a circuit breaker has a straight voltage rating, such as 240 volts, it can be used in an AC system where the voltage between any two conductors is not greater than the single voltage rating of the circuit breaker. If a circuit breaker has a slash rating, like 120/240 volts, it can be used in an AC system where the voltage between phase conductors is not greater than the higher rating (240 volts), and the voltage to ground is not greater than the lower rating (120 volts).

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***The voltage to ground on a circuit breaker with a slash rating cannot be more than the lower rating on the breaker.***

Question 46: Which of the following is permitted to supply a 3-phase load on 3-phase 480-V corner grounded system?

A: A 3-pole breaker marked 480 volts.
B: A 3-pole breaker marked 240/120 volts.
C: Three single-pole breakers marked 480/277 volts with identified handle-ties.
D: A 3-pole breaker marked 480/277 volts.

## Question 47: 240.86 Series Rating.

Question ID#: 11359.0

A series-rated system of feeder and branch-circuit breakers refers to an arrangement where the branch-circuit breakers are permitted to be used in locations where the available fault current is above the branch-circuit breaker's interrupting rating, because the feeder breaker is working with the branch-circuit breakers to protect those individual overcurrent devices. Installing a series-rated system is a way to avoid having to pay for a fully rated system, meaning a system where every branch-circuit breaker has an interrupting rating equal to or greater than the available fault current at that location. Circuit breakers above the standard 10,000 amps interrupting rating can get very expensive.

In a series-rated system, the feeder and branch circuit breakers have been tested in combination and have been proven to work together to prevent the branch circuit breaker from exploding, even when a short circuit occurs on the load side of the branch circuit breaker with fault current that rises to levels greater than the branch circuit breaker's interrupting rating.


***Series rated overcurrent protective systems are permitted, but must be labeled. Identical replacement parts are required.***

***Example - Working Together***

If a series-rated system has a feeder breaker with an interrupting rating of 22,000 amps and branch-circuit breakers with interrupting ratings of 10,000 amps, and a fault occurs downstream of the branch-circuit breaker, the fault current can climb above that interrupting rating. But at a point between 10,000 amps and 22,000 amps the feeder breaker will trip and de-energize all circuits before the single branch-circuit breaker is damaged. The resistance of the feeder breaker combined with the branch-circuit breaker in series reduces the fault current imposed on any individual branch-circuit breaker.

In a series rated system the feeder and branch-circuit breakers work together during a fault to reduce damage to the downstream breaker. The disadvantage in this configuration is that because the feeder breaker ultimately trips in order to save the system from this high current, all of the branch-circuits downstream of the feeder are then taken offline during the event.

***One Final Note***

The overcurrent devices must be labeled to identify them as being part of a series-rated system.  Only unique combinations of circuit breakers can be part of a series rated system.  If a non-series rated breaker is used to replace a component of a series rated system, it may not work properly and may put the whole system in danger.

Question  47:   Which of the following best describes a series rated system?

A: The feeder breaker and the branch circuit breaker work together to reduce the fault current seen by the branch circuit breaker.
B: The feeder and branch circuit breakers are fully rated for the available fault current.
C: The feeder breaker protects the branch circuit breaker.
D: The interrupting rating of the branch circuit breaker is not important.

## Question  48:   240.86  Series Rating.

Question ID#: 11359.1

A series-rated system of feeder and branch-circuit breakers refers to an arrangement where the branch-circuit breakers are permitted to be used in locations where the available fault current is above the branch-circuit breaker's interrupting rating, because the feeder breaker is working with the branch-circuit breakers to protect those individual overcurrent devices. Installing a series-rated system is a way to avoid having to pay for a fully rated system, meaning a system where every branch-circuit breaker has an interrupting rating equal to or greater than the available fault current at that location.  Circuit breakers above the standard 10,000 amps interrupting rating can get very expensive.


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***Example - Working Together***

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In a series rated system the feeder and branch-circuit breakers work together during a fault to reduce damage to the downstream breaker. The disadvantage in this configuration is that because the feeder breaker ultimately trips in order to save the system from this high current, all of the branch-circuits downstream of the feeder are then taken offline during the event.

***One Final Note***

The overcurrent devices must be labeled to identify them as being part of a series-rated system. Only unique combinations of circuit breakers can be part of a series rated system. If a non-series rated breaker is used to replace a component of a series rated system, it may not work properly and may put the whole system in danger.

Question 48: What is the one disadvantage in using a series-rated system for protecting branch-circuit breakers from high levels of fault current?

A: The feeder breaker is the breaker that trips when there is a fault and it must be replaced once it trips. Series-rated breakers cannot be reset after there is an event, they must be replaced each time there is a fault.
B: The feeder breaker is the breaker that trips when there is a fault and all of the branch-circuits downstream are then taken offline.
C: All of the individual branch-circuit breakers trip simultaneously when there is a fault and therefore take the feeder upstream offline.
D: All of the individual branch-circuit breakers trip simultaneously when there is a fault and they are all taken offline.

## Question 49: 240.90 & 240.2 Supervised Industrial Locations.

Question ID#: 11360.0

A supervised industrial location is defined in 240.2 as the manufacturing part of a facility that meets 3 conditions:

- ***Conditions of maintenance and engineering supervision ensure that only qualified persons monitor and service the system.***
- ***The premises wiring system has 2500 kVA or greater of load used in industrial process(es), manufacturing activities, or both, as calculated in accordance with Article 220.***
- ***The premises has at least one service or feeder that is more than 150 volts to ground and more than 300 volts phase-to-phase.***

***In supervised industrial locations, certain procedures for protecting conductors and equipment are permitted which would not be allowed in other occupancy types.***

The definition of Supervised Industrial Installation, in section 240.2, does not include those parts of the property that are used for ***"offices, warehouses, garages, machine shops, and recreational facilities."***

Supervised industrial locations are given special treatment because of the high level of engineering and professional maintenance support which is usually available in these facilities. The Code assumes that people doing electrical work in industrial facilities are ***qualified*** according to the definition in Article 100, which says a ***qualified person*** is one ***who has skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training on the hazards involved***. Not only are the electricians qualified, but they are supervised by competent professionals.

At least one of the other two conditions limit the definition of a supervised industrial installation to large manufacturing or process control plants. A 2500 kVA load calculated according to Article 220 would be over 3000 amps, assuming most of the equipment was operated at 480 volts, 3-phase (2,500,000 VA /480 x 1.73 = 3012 amps). This load excludes any part of the installation that is not manufacturing, like offices, warehouses, garages, machine shops, and recreational facilities.

Question 49: Which of the following installations would qualify as a supervised industrial installation?

A: A multi-tenant building with professional property management personnel responsible for maintenance on the property.
B: A 2500 sq. ft. bakery with 1500 kVA of load.
C: A large mall with 3000 kVA of load.
D: A tire plant with 4000 kVA of load.

## Question 50: 240.92 Overcurrent Protection in Industrial Locations.

Question ID#: 11361.0

This section loosens the requirements for transformer secondary taps and outside feeder taps in supervised industrial locations. The rules can be relaxed because of the engineering and professional maintenance support at these facilities.


***Engineers in supervised industrial locations are permitted to calculate the rating of transformer taps and outside feeder taps.***

Section 240.92(B) and table 240.92(B) permit tap conductor short-circuit current ratings to be calculated under engineering supervision. The calculated values done in accordance with table 240.92(B) may be less than are required elsewhere in the NEC.

Transformer secondary conductors shall be protected from short-circuit and ground-fault conditions if they meet the conditions of this section. However, if the ampacity of the secondary conductors is calculated under engineering supervision, the transformer secondary taps are considered protected against short-circuits, ground-faults and overloads for any distance without other conditions.

Outside feeder taps may be tapped to a feeder or connected to a transformer secondary without overcurrent protection at the tap if the sum of the overcurrent devices at the conductor termination limits the load to the conductor ampacity and there are not more than 6 overcurrent devices grouped in one location.

Question 50: Which of the following statements is true?

A: An outside feeder tap rated at 350 amps can be protected by two 200-amp fusible disconnects at the termination of the tap.
B: In supervised industrial locations, transformer secondary taps can be calculated under engineering supervision.
C: In supervised industrial locations, all transformer secondary conductors must be protected at the transformer.
D: The requirements for supervised industrial locations are the same as for any other location.

## Question 51: 240.92 Overcurrent Protection in Industrial Locations.

Question ID#: 11361.1

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Outside feeder taps may be tapped to a feeder or connected to a transformer secondary without overcurrent protection at the tap if the sum of the overcurrent devices at the conductor termination limits the load to the conductor ampacity and there are not more than 6 overcurrent devices grouped in one location.

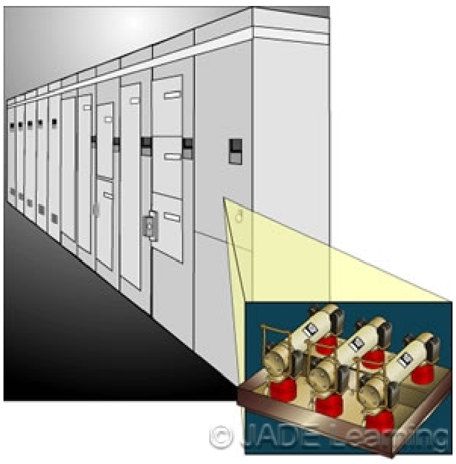
Question 51: In a Supervised Industrial Installation, the ampacity of outside feeder taps connected to the secondary of a transformer was determined and installed under engineering supervision. The ampacity of the tap conductors is equal to the ampacity of the sum of the overcurrent devices where the taps are terminated. The taps are installed in RMC and protected from physical damage.

Where can the feeder taps be terminated?

A: A switchboard with 12 switches.
B: A single meter enclosure that has 8 separate disconnects.
C: Four separate disconnects located in one location outside a building and 2 disconnects located inside the building.
D: Six fused disconnects located together outside a building.

## Question 52: 240.100 & 240.101 Overcurrent Protection over 1000 Volts, Nominal.

Question ID#: 11362.1




***The required rating of overcurrent protection in circuits over 1000 volts is larger than the required rating in circuits 1000 volts and below.***

Like in supervised industrial locations, circuits over 1000 volts in any location can be protected at locations other than at the point of supply if there is engineering supervision.

In circuits over 1000 volts, Section 240.101 requires that the rating of the fuse cannot be more than 3 times the ampacity of the conductors. The long-time trip setting of a breaker cannot be more than 6 times the ampacity of the conductor.

This is a good example of how different over 1000 volt installations are from 1000 volt and below installations. For 1000 volts and below, overcurrent protection for a conductor cannot be more than the next standard size fuse or breaker. In over 1000 volt installations, a fuse can be 3 times the rating of the conductor and a breaker can be 6 times the rating of the conductor.

Question 52: Feeders are selected and installed under engineering supervision in a supervised industrial installation. If the system voltage on the feeder is 2,300 volts and its ampacity is 200 amps, what is the maximum long-time setting for a circuit breaker protecting the feeder?

A: 1200 amps.
B: 1600 amps.
C: 600 amps.
D: 300 amps.

## Question 53: 408.30 & 408.36 Overcurrent Protection for Panelboards.

Question ID#: 11363.0

The ampere rating of a panelboard must not be less than the feeder capacity required to serve the calculated load, but the rating of the panelboard can be greater than the feeder ampacity. For example, if the feeder calculated load is 195 amperes, the panelboard ampere rating must not be less than 195 amps. A panelboard rated 200 amperes could be used, but a 225 amp or even a 400 amp rated panelboard may be used in some cases.

Panelboards are required to be protected by an overcurrent protective device that has a rating less than or equal to the rating of the panelboard. The overcurrent protective device can be a Main that is installed in the panelboard, or the overcurrent protection can be located outside the panelboard, such as when a fusible disconnect supplies a main lugs only panelboard.

Overcurrent protection for panelboards protects the panelboard busbars and the panelboard lugs where the feeder conductors terminate. The overcurrent protection required for the panelboard is sized to protect the panelboard, not necessarily the feeder conductors supplying the panelboard or the branch circuits and feeders that are supplied by the panelboard. For example, where a 100 ampere panelboard is supplied by conductors tapped to a feeder protected at 300 amps, the feeder conductors and tap conductors must be protected in accordance with the rules in Article 240, but the panelboard must be protected at 100 amps as required by 408.36.

***The rating of OC protection for a panelboard cannot be greater than the rating of the panelboard busbars.***

The panelboard rating determines the maximum overcurrent protection that can be used to protect the panelboard, and the load calculation and rating of the overcurrent protection device protecting the feeder determines the minimum ampacity of the conductors that supply the panelboard.

Question 53: A feeder fuse rated at 400 amps supplies a main lugs only panelboard. The calculated load on the panelboard is 350 amps. The feeder is 500 kcmil, rated at 380 amps. What is the minimum rating of the panelboard?

A: 400 amps.
B: 380 amps.
C: 600 amps.
D: 350 amps.

## Question 54: 408.30 & 408.36 Overcurrent Protection for Panelboards.

Question ID#: 11363.1

The ampere rating of a panelboard must not be less than the feeder capacity required to serve the calculated load, but the rating of the panelboard can be greater than the feeder ampacity. For example, if the feeder calculated load is 195 amperes, the panelboard ampere rating must not be less than 195 amps. A panelboard rated 200 amperes could be used, but a 225 amp or even a 400 amp rated panelboard may be used in some cases.

***The rating of OC protection for a panelboard cannot be greater than the rating of the panelboard busbars.***

Panelboards are required to be protected by an overcurrent protective device that has a rating less than or equal to the rating of the panelboard. The overcurrent protective device can be a Main that is installed in the panelboard, or the overcurrent protection can be located outside the panelboard, such as when a fusible disconnect supplies a main lugs only panelboard.

Overcurrent protection for panelboards protects the panelboard busbars and the panelboard lugs where the feeder conductors terminate. The overcurrent protection required for the panelboard is sized to protect the panelboard, not necessarily the feeder conductors supplying the panelboard or the branch circuits and feeders that are supplied by the panelboard. For example, where a 100 ampere panelboard is supplied by conductors tapped to a feeder protected at 300 amps, the feeder conductors and tap conductors must be protected in accordance with the rules in Article 240, but the panelboard must be protected at 100 amps as required by 408.36.

The panelboard rating determines the maximum overcurrent protection that can be used to protect the panelboard, and the load calculation and rating of the overcurrent protection device protecting the feeder determines the minimum ampacity of the conductors that supply the panelboard.

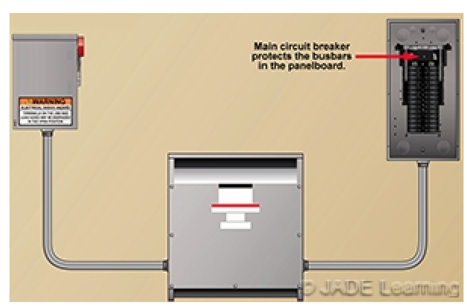
Question 54: A main-lugs-only 3-phase, 4-wire, 120/208-V panelboard in an office complex has a 225-amp rating. The panelboardâ€™s overcurrent protection is provided by a fused disconnect. The calculated load on the panelboard is 200 amps. What is the maximum rating of the fuses in the feeder disconnect?

A: 150-amps.
B: 250-amps.
C: 200-amps.
D: 225-amps.

## Question 55: 408.36(A)(B)(C)(D) Overcurrent Protection for Panelboards.

Question ID#: 11364.1

Panelboards must have overcurrent protection. The overcurrent protective device (OCPD) protecting a panelboard must have a rating that is not greater than the rating of the panelboard. This helps to ensure the panelboard will not be used at a higher capacity than it is rated for, but there are additional restrictions depending on the type of overcurrent devices that are installed within the panelboard.




***The overcurrent protection for a panelboard that is supplied from a transformer on the secondary side of a transformer must protect the panelboard busbars and the transformer secondary conductors.***

Sections 408.36(A)-(D) provides specific rules for overcurrent devices installed in panelboards.

***(A) Snap Switches Rated at 30 Amperes or Less. Panelboards equipped with snap switches rated at 30 amperes or less shall have overcurrent protection of 200 amps or less.***

Some fuse-type panelboards were equipped with snap switches that permitted the load to be disconnected prior to replacing fuses. Overcurrent protection for panelboards equipped with snap switches rated 30 amps or less must not exceed the rating of the panelboard or 200 amps, whichever is less.

***(B) Supplied Through a Transformer.*** Most panelboards that are supplied by a transformer must have the panelboard overcurrent protection located on the secondary of the transformer. However, an exception to 408.36 permits transformer primary overcurrent protection of some single-phase transformers with a 2-wire (single voltage) secondary and some 3-phase, delta-delta connected transformers with a 3-wire (single-voltage) secondary to protect the panelboard.

***(C) Delta Breakers.*** A 3-phase circuit breaker or disconnect cannot be connected to any panelboard that has less than 3-phase buses. Delta breakers shall not be installed in panelboards.

Delta breakers are an obsolete type of circuit breaker that allowed a 3-phase load to be supplied through a single-phase panelboard. The third-phase wire was connected to lugs on the breaker, rather than to the bus in the panelboard. Delta breakers have not been permitted since 1970's.

***(D) Back-Fed Devices.*** Plug-in type circuit breakers that are back-fed, used to energize the panelboard from another source, must be secured in place by an extra fastener that requires more than a pulling motion to release the circuit breaker. This is to prevent the breaker from accidental release and exposing personnel and property to live voltage.

Question 55: Which type of panelboard can 20-ampere snap-switches be installed in?

A: A single phase, 120/240-V, 3-wire, 200-amp panelboard with space for 42 overcurrent devices.
B: A single phase, 120/240-V, 3-wire, 225-amp panelboard with space for 42 overcurrent devices.
C: A 3-phase, 120/208-V, 4-wire, 225-amp panelboard with space for 24 overcurrent devices.
D: A 3-phase, 277/480-V, 4-wire, 400-amp panelboard with space for 36 overcurrent devices.

## Question 56: 422.11 Overcurrent Protection for Appliances.

Question ID#: 11365.1

If an appliance manufacturer marks an appliance with a maximum overcurrent protection size, then the branch circuit fuse or breaker cannot be larger than what is marked on the appliance. This is an example of the general statement in 110.3(B) which states: ***Listed or labeled equipment shall be installed and used in accordance with any instructions included in the listing or labeling***. The Code recognizes that the manufacturer knows his product better than anyone else and if he wants a certain size fuse or breaker to protect the appliance then that is what should be installed.

***The overcurrent protection for an appliance cannot be greater than what the manufacturer requires.***

There are requirements in this section to subdivide appliance loads once they exceed certain sizes. For example, electric heating appliances must subdivide loads larger than 48 amps into loads not larger than 48 amps, and protect each subdivided load by not more than 60 amps, see 422.11(F).

Subdividing loads is another way of protecting the equipment. A 100 amp electric heating appliance will be better protected by two 50 amp breakers than one 100 amp breaker because the faulted heating element will be taken offline quicker. Problems on 50 amp circuits are not as bad as problems on 100 amp circuits.

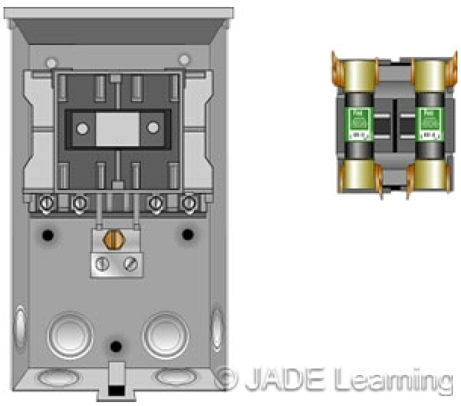
Other appliances like infrared lamp commercial and industrial heating appliances, household-type appliances with surface heating elements and commercial kitchen and cooking appliances are discussed here with specific overcurrent requirements.

Question 56: Which of the following violates the requirements for household electric heating appliances with resistance-type heating elements?

A: A 120-V, 15-amp appliance being supplied by a 20-amp circuit.
B: A single 60-amp, 240-V circuit supplying a 50-amp household heating appliance with two subdivided loads installed by the manufacturer with each protected by 25 amp overcurrent protection.
C: A 240-V, 50-amp appliance with no internal overcurrent protection supplied by a single 60-amp circuit.
D: A 240-V, 15-amp appliance being supplied by a 20-amp circuit.

## Question 57: 424.3(B) and 424.22(B) Fixed Electric Space-Heating Equipment Overcurrent Protection.

Question ID#: 11366.1



***Fuses used to protect fixed electric space-heating equipment must be sized at no less than 125% of the total load on the equipment.***

For the purpose of sizing the branch circuit, the NEC considers fixed electric space heating equipment a continuous load according to 424.3(B). Branch circuit overcurrent protection for fixed electric space-heating equipment must be sized at no less than 125% of the combined load on the resistance elements and any motors.

Loads larger than 48 amps must be subdivided and protected at not more than 60 amps. Each of the subdivided loads must have supplementary overcurrent protection in addition to the branch circuit fuse or breaker. The supplementary overcurrent protection must also be sized at no less than 125% of the load, but it is provided by the equipment manufacturer.

Question 57: A fixed electric space-heating piece of equipment is rated 60 amperes. The manufacturer has installed internal fuseholders for supplemental overcurrent protection for the three 20-amp resistance strip heating elements. What is the correct rating of the fuse for the internal subdivided loads?

A: 60-amps.
B: 25-amps.
C: 20-amps.
D: 15-amps.

## Question 58: 430.52 Motor Branch-Circuit Short-Circuit and Ground-fault Protection.

Question ID#: 11367.0

***Branch-circuit and short-circuit protection for a single motor is selected from Table 430.52, based on the full load current of the motor.***

In a general-purpose branch circuit, a circuit breaker or fuse provides short-circuit, ground-fault, and overload protection for the circuit conductors, but in a motor circuit overcurrent protection is typically accomplished using two separate devices. A circuit breaker or fuse provides short-circuit and ground-fault protection and a separate overload device in the motor or motor controller protects against overloads.

Figure 430.1 in the NEC shows a one-line drawing for a typical motor circuit that includes the placement of both the motor branch-circuit short-circuit and ground-fault protective device, and the separate overload protection device.

Section 430.52 provides the rules for sizing circuit breakers and fuses that provide the short-circuit and ground-fault protection for motor branch circuits. The branch circuit fuse or circuit breaker must be capable of carrying the starting current of the motor.

Table 430.52, ***Maximum Rating or Setting of Motor Branch-Circuit Short-Circuit and Ground-Fault Protective Devices***, is used to size the short-circuit and ground-fault overcurrent device. The Table uses a percentage of the motor full-load current to calculate the maximum rating of the motor branch-circuit short-circuit ground-fault protective device. To perform these calculations, use the motor full-load currents found in Table 430.248 for single-phase AC motors, and Table 430.250 for 3-phase AC motors.

The most common short-circuit and ground-fault protective devices used for motor and motor branch-circuit protection are the Dual Element Time-Delay Fuse and the Inverse Time Breaker. When using a Time-Delay Fuse, the ampere rating of the fuse is selected so as to not exceed 175% of the motor FLC for most motor applications. Where 175% of the FLC does not correspond with a standard fuse rating, the next higher standard rating can be used in accordance with Exception No. 1. Where an Inverse Time Breaker is used, the breaker is selected so as not to exceed 250% of the motor FLC for most motor applications. Exception No. 1 also permits the next higher standard rating to be used where 250% of the FLC does not correspond with a standard circuit breaker rating.

Example 1:
What is the maximum rating for a Time-Delay Fuse used to protect a 2 hp, 208 V, 1-phase AC motor?

Determine the motor FLC using Table 430.248: FLC = 13.2 amps.
Table 430.52 shows a multiplier of 175%, 1.75, to be applied to the motor FLC when using Time-Delay Fuses, 13.2 amps x 1.75 = 23.1 amps.

Since the calculated fuse rating is not a standard fuse rating, 430.52(C)(1) Exception 1 permits the next higher standard fuse to be used,

The next standard fuse rating is 25 amps.

See Table 240.6 for standard ratings for fuses and inverse time circuit breakers.

Example 2:

What is the maximum rating for an Inverse Time Breaker for a 10 hp, 230 V, 3-phase motor?

Table 430.250, FLC = 28 amps.
Table 430.52 for an Inverse Time breaker, 250%, 2.5.
The calculated rating is: 28 amps x 2.5 = 70 amps. A 70 amp breaker can be used for this motor short-circuit and ground-fault protection.

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Note: There are two exceptions to 430.52(C)(1) that allow the rating of the fuse or circuit breaker to be increased under certain conditions.

Question 58: What are the correct size time delay fuses for a 15 hp, 460 volt, 3-phase AC, squirrel-cage induction motor that has a Full Load Current (FLC) rating of 21 amps?

A: 50 amps.
B: 35 amps.
C: 60 amps.
D: 40 amps.

## Question 59: 430.52 Motor Branch-Circuit Short-Circuit and Ground-fault Protection.

Question ID#: 11367.1


***Branch-circuit and short-circuit protection for a single motor is selected from Table 430.52, based on the full load current of the motor.***

In a general-purpose branch circuit, a circuit breaker or fuse provides short-circuit, ground-fault, and overload protection for the circuit conductors, but in a motor circuit overcurrent protection is typically accomplished using two separate devices. A circuit breaker or fuse provides short-circuit and ground-fault protection and a separate overload device in the motor or motor controller protects against overloads.

Figure 430.1 in the NEC shows a one-line drawing for a typical motor circuit that includes the placement of both the motor branch-circuit short-circuit and ground-fault protective device, and the separate overload protection device.

Section 430.52 provides the rules for sizing circuit breakers and fuses that provide the short-circuit and ground-fault protection for motor branch circuits. The branch circuit fuse or circuit breaker must be capable of carrying the starting current of the motor.

Table 430.52, ***Maximum Rating or Setting of Motor Branch-Circuit Short-Circuit and Ground-Fault Protective Devices***, is used to size the short-circuit and ground-fault overcurrent device. The Table uses a percentage of the motor full-load current to calculate the maximum rating of the motor branch-circuit short-circuit ground-fault protective device. To perform these calculations, use the motor full-load currents found in Table 430.248 for single-phase AC motors, and Table 430.250 for 3-phase AC motors.

The most common short-circuit and ground-fault protective devices used for motor and motor branch-circuit protection are the Dual Element Time-Delay Fuse and the Inverse Time Breaker. When using a Time-Delay Fuse, the ampere rating of the fuse is selected so as to not exceed 175% of the motor FLC for most motor applications. Where 175% of the FLC does not correspond with a standard fuse rating, the next higher standard rating can be used in accordance with Exception No. 1. Where an Inverse Time Breaker is used, the breaker is selected so as not to exceed 250% of the motor FLC for most motor applications. Exception No. 1 also permits the next higher standard rating to be used where 250% of the FLC does not correspond with a standard circuit breaker rating.

Example 1:
What is the maximum rating for a Time-Delay Fuse used to protect a 2 hp, 208 V, 1-phase AC motor?

Determine the motor FLC using Table 430.248: FLC = 13.2 amps.
Table 430.52 shows a multiplier of 175%, 1.75, to be applied to the motor FLC when using Time-Delay Fuses, 13.2 amps x 1.75 = 23.1 amps.

Since the calculated fuse rating is not a standard fuse rating, 430.52(C)(1) Exception 1 permits the next higher standard fuse to be used,

The next standard fuse rating is 25 amps.

See Table 240.6 for standard ratings for fuses and inverse time circuit breakers.

Example 2:

What is the maximum rating for an Inverse Time Breaker for a 10 hp, 230 V, 3-phase motor?

Table 430.250, FLC = 28 amps.
Table 430.52 for an Inverse Time breaker, 250%, 2.5.
The calculated rating is: 28 amps x 2.5 = 70 amps. A 70 amp breaker can be used for this motor short-circuit and ground-fault protection.

Note: There are two exceptions to 430.52(C)(1) that allow the rating of the fuse or circuit breaker to be increased under certain conditions.

Question 59: What is the maximum rating of an inverse time circuit breaker for a squirrel-cage, Design C, 15 hp, 575-volt, 3-phase AC motor that has a full-load current (FLC) rating of 17 amps?

A: 40-amps.
B: 30-amps.
C: 45-amps.
D: 17-amps.

## Question 60: 430.52(C)(1) Ex. 2 When the Motor Will Not Start.

Question ID#: 11368.1

***If a motor will not start, higher values of overcurrent protection can be selected.***

Section 430.52 (C)(1) Exception No. 2 allows the percentages in Table 430.52, which are used to size the branch-circuit and ground-fault protective devices, to be increased if the motor will not start.

There are thousands of different applications for electric motors. Motors drive fans, pumps, conveyors, compressors, tools and all types of machinery. The length of time it takes the motor to start depends on the type of load it is driving. If a motor must start under load the fuse might blow or the breaker might trip before the motor gets the load moving.

There is no way to predict how every motor will be used and what the safest size overcurrent device is to both protect the circuit and allow the motor to start. So Exception No. 2 allows the installer to increase the size of the device if the original fuse or breaker will not allow the motor to start.

According to Exception No. 2, if a motor will not start, the overcurrent device can be increased but cannot be larger than the Full Load Amps of the motor times the maximum setting of the overcurrent device as specified in exception #2. This means if the rating of the overcurrent device is between 2 standard sizes, the next lower size must be chosen.

***OCPD ratings as a % of FLA for single phase & 3-Phase Motors***

| ***Overcurrent Device*** | ***Normal Setting*** | ***Maximum Setting*** |
|---|---|---|
| Non-time Delay Fuse | 300% of FLA | 400% of FLA |
| Dual Element Time Delay Fuse | 175% of FLA | 225% of FLA |
| Inverse Time Breaker 100-A or less | 250% of FLA | 400% of FLA |
| Inverse Time Breaker or more than 100-A | | |

250% of FLA

300% of FLA

Example #1:
A 25 hp, 3-phase 460 volt AC motor that draws 34 FLA will not start under load. What is the maximum size time delay fuse?
Calculation: 34 amps x 225% = 76.5 amps. Select the next ***lower*** standard size fuse = 70 amps

Example #2:
A 15 hp, 3-phase 230 volt AC motor that draws 42 FLA will not start under load. What is the maximum size inverse time circuit breaker?
Calculation: 42 amps x 400% = 168 amps. Select the next ***lower*** standard size inverse time circuit breaker = 150 amps

Question 60: If a 7 Â½-HP, 3-phase, 208 volt squirrel cage motor with a full-load current rating of 24.2 amperes will not start under load, which of the following is the maximum size Nontime Delay Fuse permitted to be used?

A: 100-amp.
B: 80-amp.
C: 70-amp.
D: 90-amp.

## Question 61: 430.62 Motor Feeder Short-Circuit and Ground-Fault Protection.

Question ID#: 11369.0

***A motor feeder that supplies more than a single motor is protected according to the requirements in Code section 430.62.***

Where feeders sized in accordance with 430.24 supply multiple motor branch-circuits, the overcurrent protection device that protects the feeder conductors must also allow the motors to start. The motor feeder overcurrent protective device is sized in 4 steps:

- Determine the maximum rating of the largest motor branch-circuit short-circuit ground-fault protection device based on the specific type of overcurrent device as permitted by 430.52.
- Determine the total FLC of all the other motors on the feeder, as determined using the appropriate FLC motor tables from Article 430.
- Add the maximum OCPD rating (Step 1) to the sum total FLC of all motors in the group (Step 2).
- Select the next ***lower*** standard overcurrent protective device if the calculated value does not equal a standard size from Table 240.6(A)(1).

Example 1:

A feeder protected with time delay fuses supplies three 10 hp, 3-phase, 230 volt AC motors. The FLC of each motor is 28 amps.

Calculation process:

- The full-load current for a 10 hp, 3-phase, 230 volt AC motor is 28 amp (Table

430.250).

Per Table 430.52, use 175% of motor FLC for sizing a time delay fuse.

28 A X 1.75 = 49 amps.

Exception No.1 permits a 50 amp fuse to be used.

- Add the FLC of the remaining motors together, 28 amps + 28 amps = 56 amps.
- Add the rating of the largest OCPD (50-amps) to the total FLC of the remaining motors, 50 amps + 56 amps = 106 amps.
- For a calculated value of 106 amps, use the next lower standard fuse rating, (100 amps).

Example 2:

A feeder protected with an inverse time breaker that supplies a circuit with a 10 hp, 3-phase, 460 volt AC motor, and a 15 hp, 3-phase, 460 volt AC motor must be protected with a breaker rated no larger than 70-A, if the largest motor branch-circuit OCPD is 60-A.

Calculation process:

- The full-load current for a 15 hp, 3-phase, 460 volt AC motor is 21 amps (Table 430.250).

The rating for an inverse time breaker is calculated using 21 A X 2.5 = 52.5 amps (Table 430.52). The next highest standard breaker rating is 60 amps.

- The FLC of the other motor is 14 amps.
- Add the rating of the largest OCPD to the remaining motor FLC, 60 amps + 14 amps = 74 amps.

With a calculated value of 74 amps, use the next lower standard size breaker, 70-A.

Question 61: A feeder supplies three, 15 hp, 208 volt, 3-phase AC motors. The feeder and all the branch circuit devices are protected by time delay fuses. The Full Load Current (FLC) for a 15 hp, 3-phase 208 volt AC motor is 46.2 amps. The branch circuits are protected by 90 amp time delay fuses. What is the maximum size feeder fuse?

A: 90 amp.
B: 200 amp.
C: 150 amp.
D: 175 amp.

## Question 62: 430.62 Motor Feeder Short-Circuit and Ground-Fault Protection.

Question ID#: 11369.1


***A motor feeder that supplies more than a single motor is protected according to the requirements in Code section 430.62.***

Where feeders sized in accordance with 430.24 supply multiple motor branch-circuits, the overcurrent protection device that protects the feeder conductors must also allow the motors to start. The motor feeder overcurrent protective device is sized in 4 steps:

- Determine the maximum rating of the largest motor branch-circuit short-circuit ground-fault protection device based on the specific type of overcurrent device as permitted by 430.52.
- Determine the total FLC of all the other motors on the feeder, as determined using the appropriate FLC motor tables from Article 430.
- Add the maximum OCPD rating (Step 1) to the sum total FLC of all motors in the group (Step 2).
- Select the next ***lower*** standard overcurrent protective device if the calculated value does not equal a standard size from Table 240.6(A)(1).

Example 1:

A feeder protected with time delay fuses supplies three 10 hp, 3-phase, 230 volt AC motors. The FLC of each motor is 28 amps.

Calculation process:

- The full-load current for a 10 hp, 3-phase, 230 volt AC motor is 28 amp (Table 430.250).

Per Table 430.52, use 175% of motor FLC for sizing a time delay fuse.

28 A X 1.75 = 49 amps.

Exception No.1 permits a 50 amp fuse to be used.

- Add the FLC of the remaining motors together, 28 amps + 28 amps = 56 amps.
- Add the rating of the largest OCPD (50-amps) to the total FLC of the remaining motors, 50 amps + 56 amps = 106 amps.
- For a calculated value of 106 amps, use the next lower standard fuse rating, (100 amps).

Example 2:

A feeder protected with an inverse time breaker that supplies a circuit with a 10 hp, 3-phase, 460 volt AC motor, and a 15 hp, 3-phase, 460 volt AC motor must be protected with a breaker rated no larger than 70-A, if the largest motor branch-circuit OCPD is 60-A.

Calculation process:

- The full-load current for a 15 hp, 3-phase, 460 volt AC motor is 21 amps (Table 430.250).

The rating for an inverse time breaker is calculated using 21 A X 2.5 = 52.5 amps (Table 430.52). The next highest standard breaker rating is 60 amps.

- The FLC of the other motor is 14 amps.
- Add the rating of the largest OCPD to the remaining motor FLC, 60 amps + 14 amps = 74 amps.

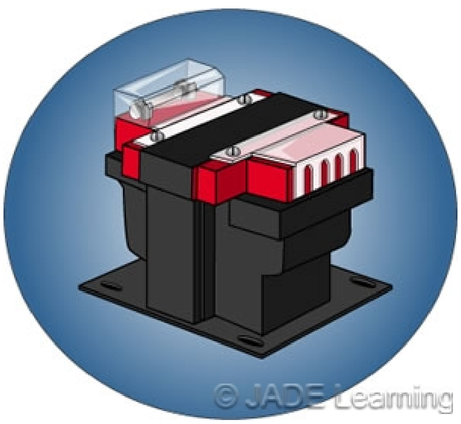
With a calculated value of 74 amps, use the next lower standard size breaker, 70-A.

Question 62: A feeder supplies four 460-volt, 10-HP, 3-phase, squirrel-cage motors with a full-load current of 14-amperes each. The feeder and all the branch circuit devices are protected by time delay fuses. Because the motors would not start with smaller branch circuit fuses, the four branch circuits are protected by 30-amp time delay fuses. What is the maximum size time delay fuse permitted to protect the feeder?

A: 70 amps.
B: 60 amps.
C: 80 amps.
D: 90 amps.

## Question 63: 430.72 Overcurrent Protection of Motor Control Circuits.

Question ID#: 11370.0




***A motor control circuit transformer must have overcurrent protection.***

Motor control circuits can be powered in 3 different ways: (1) They can be tapped from the motor branch circuit, in which case the motor control devices, like pushbuttons and limit switches, operate at the same voltage as the motor. (2) They can be supplied by a motor control transformer, with the primary of the control transformer being tapped from the load side of the motor branch circuit overcurrent protective device. (3) They can be supplied from a source completely separate from the motor branch circuit.

The preferred method usually depends on the size of the installation and how it is configured. If the motor starters and branch-circuit overcurrent protection devices are in motor control centers, motor control transformers are typically used. If motor control panels are installed, a power supply is usually installed. Motor control circuits tapped to the motor branch-circuit conductors are not as common as the other 2 methods because of the higher voltages present on motor control devices.

Table 430.72(B) provides the maximum rating of overcurrent devices used to protect motor control conductors. This table covers installations where the motor control conductors are tapped to the motor branch-circuit conductors. It lists the maximum setting of overcurrent devices if separate protection is provided for the motor control conductors or if only the motor branch-circuit fuses or breakers protect the conductors.

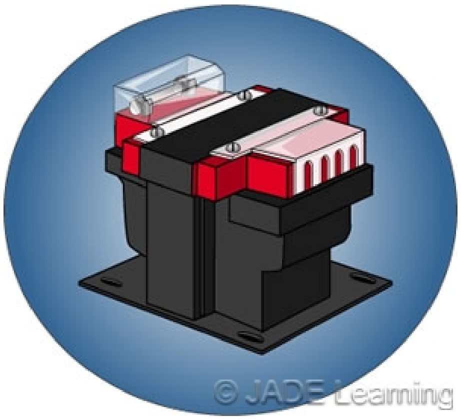
Where a control circuit transformer with a primary rating of less than 2 amps is installed to feed a motor control circuit it must be separately protected by an overcurrent device with a rating not more than 500% of the rated primary current of the control transformer.

Question 63: Which fuse size would properly protect a control transformer with a primary rating of 1.5 amps when the fuse is installed on the primary of the transformer?

A: 9 amps.
B: 7 amps.
C: 10 amps.
D: 8 amps.

## Question 64: 430.72 Overcurrent Protection of Motor Control Circuits.

Question ID#: 11370.1




***A motor control circuit transformer must have overcurrent protection.***

Motor control circuits can be powered in 3 different ways: (1) They can be tapped from the motor branch circuit, in which case the motor control devices, like pushbuttons and limit switches, operate at the same voltage as the motor. (2) They can be supplied by a motor control transformer, with the primary of the control transformer being tapped from the load side of the motor branch circuit overcurrent protective device. (3) They can be supplied from a source completely separate from the motor branch circuit.

The preferred method usually depends on the size of the installation and how it is configured. If the motor starters and branch-circuit overcurrent protection devices are in motor control centers, motor control transformers are typically used. If motor control panels are installed, a power supply is usually installed. Motor control circuits tapped to the motor branch-circuit conductors are not as common as the other 2 methods because of the higher voltages present on motor control devices.

Table 430.72(B) provides the maximum rating of overcurrent devices used to protect motor control conductors. This table covers installations where the motor control conductors are tapped to the motor branch-circuit conductors. It lists the maximum setting of overcurrent devices if separate protection is provided for the motor control conductors or if only the motor branch-circuit fuses or breakers protect the conductors.

Where a control circuit transformer with a primary rating of less than 2 amps is installed to feed a motor control circuit it must be separately protected by an overcurrent device with a rating not more than 500% of the rated primary current of the control transformer.

Question 64: Which of the following fuses is the maximum size permitted to protect a control circuit supplied by a transformer with a rated primary current of 1.75-amps?

A: 6 amps.
B: 8 amps.
C: 7 amps.
D: 9 amps.

## Question 65: 440.22 Motor Compressor Branch-Circuit Short-Circuit and Ground-Fault Protection.

Question ID#: 11371.1


***Overcurrent protection for a motor compressor must be selected according to the manufacturer's instructions or the rules of this section, whichever is smaller.***

Branch circuit short-circuit and ground-fault protection for motor compressors is similar to overcurrent protection for motor branch circuits as found in Article 430.

In section 440.22(C) it says if there is a conflict between the size of the branch circuit protective device as calculated by Code rules and the size of the device specified by the manufacturer, and the manufacturer's size is smaller, then the manufacturer's size must be used. This is another example of the Code requiring electrical installations to follow the manufacturer's instructions, believing no one knows the equipment like the company that built it.

The branch circuit (fuse or breaker) can be rated at not more than 175% of the compressor full load current. What this means is, if 175% does not correspond to a standard size you need to round down to the next lower standard size found in code section 240.6(A). If the next lower setting will not allow the compressor to start then you can increase the overcurrent protection size to a maximum of 225% of the compressor's FLA.

Whichever percentage is applied, the next lower standard size device must be used because it must have a rating ***not exceeding*** 175% or 225%.

Example 1:
A motor compressor draws 18 amps. 18 amps x 175% = 31.5 amps. Select the next lowest standard size fuse = 30 amps.

Example 2:
A 45 amp circuit breaker installed to protect a motor compressor rated at 26 amps keeps tripping. The circuit breaker size may be increased to 50 amps. 26 x 225% = 58.5 amps. Select the next lower standard size breaker.

Question 65: If there is no problem starting a heat-pump motor compressor that has a rated load current of 27-amps, what is the largest branch circuit overcurrent protective device permitted if the circuit does not supply any load other than the compressor motor?

A: 30-amps.
B: 40-amps.
C: 45-amps.
D: 35-amps.

## Question 66: 450.3(A) Overcurrent Protection for Transformers Over 1000 Volts.

Question ID#: 11372.0


***Overcurrent protection for transformers with primaries or secondaries rated over 1000 volts is selected from Table 450.3(A).***

Table 450.3(A) lists the maximum overcurrent protection size for transformers over 1000 volts. Transformers are listed according to their impedance and whether or not they are located in a supervised location.

Transformers in supervised locations are not required to protect the secondary in some installations. Those transformers that have the primary fused at 250% or have the primary protected with a breaker rated at no more than 300% of the primary current are not required to provide overcurrent protection on the secondary. All other installations covered in Table 450.3(A) require secondary protection.

To use Table 450.3(A), you must know where the transformer will be used, and the transformer's impedance. Will the transformer be installed in a supervised location in accordance with note 3, and what is the rated impedance of the transformer? The answers to these questions will determine the overcurrent protection requirements for the transformer installation.

All transformers with a primary voltage over 1,000 volts require primary protection. The type protection, circuit breaker or fuse, will determine what percentage of the transformer-rated current is used to determine the maximum allowable rating of the primary side overcurrent protection.

To determine primary protection, determine where the transformer will be located, and what type of overcurrent protection will be used for the primary. Then multiply the transformer-rated primary current by the appropriate percentage in Table 450.3(A). Check to determine if any of the notes apply to the installation.

Once you identify the location and impedance, and have sized the primary protection, the information needed to size the secondary protection, when required, is found in the same row used to determine the primary protection. The secondary voltage will be 1,000 volts or less, or over 1,000 volts. When the secondary voltage is 1,000 volts or less, the breakers and fuses are sized using the same percentage of the transformer-rated current. A secondary operating at more than 1,000 volts will have ratings that vary between breakers and fuses.

The notes applied throughout the table are very important and must be understood. Note 1 says the next higher standard size overcurrent device may be used. If Note 1 is not mentioned in the table then the next lower standard size fuse or breaker must be selected. Note 5 allows a transformer with coordinated thermal overload protection installed by the manufacturer to omit secondary overcurrent protection.

Question 66: A transformer in a supervised location with a rated impedance of 8% has an over 1000 volt primary and under 1000 volt secondary. When secondary overcurrent protection is required, what is the maximum percentage of the rated secondary current for a fuse or circuit breaker?

A: 250%
B: 300%
C: 125%
D: 400%

## Question 67: 450.3(A) Overcurrent Protection for Transformers Over 1000 Volts.

Question ID#: 11372.1

***Overcurrent protection for transformers with primaries or secondaries rated over 1000 volts is selected from Table 450.3(A).***

Table 450.3(A) lists the maximum overcurrent protection size for transformers over 1000 volts. Transformers are listed according to their impedance and whether or not they are located in a supervised location.

Transformers in supervised locations are not required to protect the secondary in some installations. Those transformers that have the primary fused at 250% or have the primary protected with a breaker rated at no more than 300% of the primary current are not required to provide overcurrent protection on the secondary. All other installations covered in Table 450.3(A) require secondary protection.

To use Table 450.3(A), you must know where the transformer will be used, and the transformer's impedance. Will the transformer be installed in a supervised location in accordance with note 3, and what is the rated impedance of the transformer? The answers to these questions will determine the overcurrent protection requirements for the transformer installation.

All transformers with a primary voltage over 1,000 volts require primary protection. The type protection, circuit breaker or fuse, will determine what percentage of the transformer-rated current is used to determine the maximum allowable rating of the primary side overcurrent protection.

To determine primary protection, determine where the transformer will be located, and what type of overcurrent protection will be used for the primary. Then multiply the transformer-rated primary current by the appropriate percentage in Table 450.3(A). Check to determine if any of the notes apply to the installation.

Once you identify the location and impedance, and have sized the primary protection, the information needed to size the secondary protection, when required, is found in the same row used to determine the primary protection. The secondary voltage will be 1,000 volts or less, or over 1,000 volts. When the secondary voltage is 1,000 volts or less, the breakers and fuses are sized using the same percentage of the transformer-rated current. A secondary operating at more than 1,000 volts will have ratings that vary between breakers and fuses.

The notes applied throughout the table are very important and must be understood. Note 1 says the next higher standard size overcurrent device may be used. If Note 1 is not mentioned in the table then the next lower standard size fuse or breaker must be selected. Note 5 allows a transformer with coordinated thermal overload protection installed by the manufacturer to omit secondary overcurrent protection.

Question 67: A transformer in a supervised location has a rated impedance of 10% and both the primary and secondary voltage exceed 1000-volts. If secondary overcurrent protection is required, what is the maximum percentage of the rated secondary current for a fuse if the transformer does not have coordinated thermal overload protection installed by the manufacturer?

A: 250%
B: 300%
C: 225%
D: 400%

## Question 68: Table 450.3(B) Overcurrent Protection for Transformers 1000 Volts or less.

Question ID#: 11373.0


***Overcurrent protection for transformers rated 1000 volts or less is selected based on the current rating of the transformer and whether or not OC protection is provided on the primary of the transformer.***

Table 450.3(B) lists the required overcurrent protection for transformers with both primary and secondary voltages 1000 volts or less. Primary overcurrent protection is always required. The rating of the primary overcurrent protection also affects the rating of transformer secondary overcurrent protection.

Transformers rated 9 amps or more with primary overcurrent protection rated 125% of the transformer-rated current do not require secondary overcurrent protection. Note 1 applies to this installation, ***where 125% of this current does not correspond to a standard rating . . . a higher rating that does not exceed the next higher standard rating shall be permitted.*** The next higher rating is not permitted where the rated primary current is less than 9 amps.

Where transformers having primary and secondary currents of 9 amps or more are protected on both the primary and secondary of the transformer, the primary overcurrent protection can be sized based on 250% of the rated primary current, if the secondary is protected at no more than 125% of the rated current. In this case Note 1 only applies to the secondary protection, so on the secondary side the calculation can be rounded up to the next higher standard rating for an overcurrent device. This does not apply to the primary side, the primary overcurrent protection is not permitted to be increased above the calculated value based on 250% of the rated primary current.

Example 1:
A 75 kVA transformer with a 208 volt, 3-phase secondary has a rated secondary current of 208 amps, 208 amps x 1.25 = 260 amps.

Go up to the next standard size.
The maximum overcurrent protection is 300 amps.

Example 2:
A 50 kVA transformer with a 480 volt, 1-phase primary has a rated current of 104 amps, 104 amps x 2.50 = 260 amps.

Go down to the next smaller standard size.

The maximum overcurrent protection is 250 amps.

Question 68: If a 100 kva transformer is operating at 1000 volts or less, and it is equipped with over current protection on both the primary and secondary side. And the OCPD for the primary side of the transformer is sized at the maximum allowed 250% of the primary current rating, and the secondary current rating of the transformer is known to be 278 amps? what is the maximum overcurrent protection permitted for that 278 amp secondary side?

A: 400 amps.
B: 300 amps.
C: 250 amps.
D: 350 amps.

## Question 69: Table 450.3(B) Overcurrent Protection for Transformers 1000 Volts or less.

Question ID#: 11373.1


***Overcurrent protection for transformers rated 1000 volts or less is selected based on the current rating of the transformer and whether or not OC protection is provided on the primary of the transformer.***

Table 450.3(B) lists the required overcurrent protection for transformers with both primary and secondary voltages 1000 volts or less. Primary overcurrent protection is always required. The rating of the primary overcurrent protection also affects the rating of transformer secondary overcurrent protection.

Transformers rated 9 amps or more with primary overcurrent protection rated 125% of the transformer-rated current do not require secondary overcurrent protection. Note 1 applies to this installation, ***where 125% of this current does not correspond to a standard rating . . . a higher rating that does not exceed the next higher standard rating shall be permitted.*** The next higher rating is not permitted where the rated primary current is less than 9 amps.

Where transformers having primary and secondary currents of 9 amps or more are protected on both the primary and secondary of the transformer, the primary overcurrent protection can be sized based on 250% of the rated primary current, if the secondary is protected at no more than 125% of the rated current. In this case Note 1 only applies to the secondary protection, so on the secondary side the calculation can be rounded up to the next higher standard rating for an overcurrent device. This does not apply to the primary side, the primary overcurrent protection is not permitted to be increased above the calculated value based on 250% of the rated primary current.

Example 1:
A 75 kVA transformer with a 208 volt, 3-phase secondary has a rated secondary current of 208 amps, 208 amps x 1.25 = 260 amps.

Go up to the next standard size.
The maximum overcurrent protection is 300 amps.

Example 2:
A 50 kVA transformer with a 480 volt, 1-phase primary has a rated current of 104 amps, 104 amps x 2.50 = 260 amps.

Go down to the next smaller standard size.

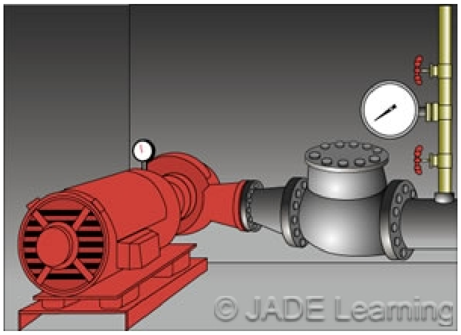
The maximum overcurrent protection is 250 amps.

Question 69: A transformer that operates at 1000 volts or less does not have coordinated thermal overload protection. If it is provided with both primary and secondary protection, what is the maximum primary overcurrent protection permitted if the rated primary current is 125-amps?

A: 300-amps.
B: 200-amps.
C: 250-amps.
D: 150-amps.

## Question 70: 695.4 Continuity of Power for Fire Pumps.

Question ID#: 11374.0




***Overcurrent protection for fire pumps is sized based on the locked-rotor current, not full-load current rating.***

A fire pump supplies water to the sprinkler system. If the fire pump does not work then the sprinklers do not work and there is no water to suppress a fire. It is much better for the fire pump to burn up than the building.

When a disconnect and overcurrent devices are used, (1) the disconnect must be suitable for use as service equipment, (2) the disconnect must be lockable in the closed position, and (3) the disconnect must be separate from other building disconnecting means and labeled as "Fire Pump Disconnecting Means" so that no one disconnects the fire pump by mistake.

The overcurrent protection is selected to carry the locked rotor current of the fire pump motor and any auxiliary equipment like jockey pumps. In other words, the overcurrent protection would not de-energize the fire pump circuit even if the pump was completely locked-up.

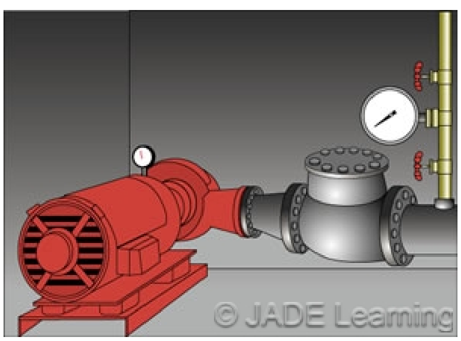
Overcurrent protection for fire pumps is different than other types of protection. There is no overload protection for the fire pump if overcurrent devices are sized to continuously carry locked rotor current.

Question 70: A fused disconnect is installed for a fire pump. Which of the following statements is true?

A: Fuses are not used to protect the fire pump from overloads.
B: The disconnect may be grouped with other motor disconnects.
C: The fuses are sized to carry 175% of the motor full load current.
D: The fuses protect the fire pump from overloads.

## Question 71: 695.4 Continuity of Power for Fire Pumps.

Question ID#: 11374.1




***Overcurrent protection for fire pumps is sized based on the locked-rotor current, not full-load current rating.***

A fire pump supplies water to the sprinkler system. If the fire pump does not work then the sprinklers do not work and there is no water to suppress a fire. It is much better for the fire pump to burn up than the building.

When a disconnect and overcurrent devices are used, (1) the disconnect must be suitable for use as service equipment, (2) the disconnect must be lockable in the closed position, and (3) the disconnect must be separate from other building disconnecting means and labeled as "Fire Pump Disconnecting Means" so that no one disconnects the fire pump by mistake.

The overcurrent protection is selected to carry the locked rotor current of the fire pump motor and any auxiliary equipment like jockey pumps. In other words, the overcurrent protection would not de-energize the fire pump circuit even if the pump was completely locked-up.

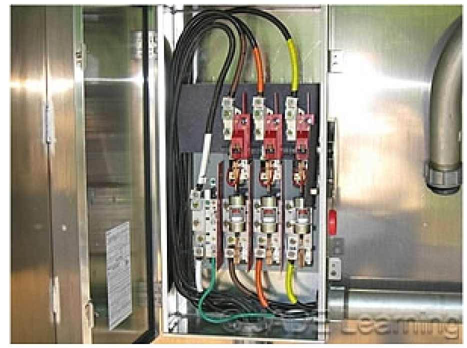
Overcurrent protection for fire pumps is different than other types of protection. There is no overload protection for the fire pump if overcurrent devices are sized to continuously carry locked rotor current.

Question 71: If an overcurrent protective device (OCPD) in a listed fire pump controller supplies a fire pump and no other equipment, which of the following is the minimum size OCPD permitted for a fire pump motor with a full-load current of 156 amps and a locked rotor current of 908 amps?

A: 1000-amp.
B: 1200-amp.
C: 300-amp.
D: 500-amp.

## Question 72: 230.90 Overcurrent Protection of Ungrounded Service Conductors.

Question ID#: 11375.0



***Each ungrounded service conductor must have overcurrent protection, based on the calculated load of the building.***

An overcurrent device must be placed in series with each ungrounded service conductor. An overcurrent device may be placed in series with a grounded conductor only if the circuit breaker simultaneously opens all conductors of the circuit.

The service overcurrent device is selected to protect service conductors from overloads above the allowable ampacity of the conductor, but the overcurrent device rating may exceed the ampacity of the conductor if permitted by one of the five exceptions to 230.90.

Exception No. 1 refers to motor loads and provides an allowance for motor-starting currents and allows motor loads to be calculated using Article 430.

Exception No. 2 states that service overcurrent protection may follow 240.4(B) or (C), which allows the next higher standard setting of overcurrent devices, ***if*** the service is rated 800 amps or less. When service calculations call for overcurrent protection devices larger than 800-A, you must size down to the next lowest standard.

Exception No. 3 states provision for two to six sets of circuit breakers or fuses to be used to provide overload protection. The sum of the ratings of the circuit breakers or fuses can be larger than the ampacity of the service conductors, providing the service conductors are sized to carry the calculated load.

Exception No. 4 refers to overcurrent protection for fire pumps.

Exception No. 5 allows service overcurrent protection for 120/240-volt, 3-wire, single-phase dwelling services to be selected in accordance with 310.15(B)(7).

Question 72: Which of the following is a Code VIOLATION?Â  All equipment is rated for use as service equipment.

A: AÂ 600 amp main breaker protecting conductors rated for 590 ampsÂ serving a calculated load of 500 amps.
B: A 200-amp panelÂ with aÂ 200 amp main breakerÂ protectingÂ a calculated load of 170 amps.
C: 1200 amp fuses, protecting a calculated load of 975 amps, withÂ wire rated for 1140 amps.
D: 400 amp fuses in the ungrounded conductorsÂ used to protectÂ a calculated service load of 360 amps.

## Question 73: 230.90 Overcurrent Protection of Ungrounded Service Conductors.

Question ID#: 11375.1

***Each ungrounded service conductor must have overcurrent protection, based on the calculated load of the building.***

An overcurrent device must be placed in series with each ungrounded service conductor. An overcurrent device may be placed in series with a grounded conductor only if the circuit breaker simultaneously opens all conductors of the circuit.

The service overcurrent device is selected to protect service conductors from overloads above the allowable ampacity of the conductor, but the overcurrent device rating may exceed the ampacity of the conductor if permitted by one of the five exceptions to 230.90.

Exception No. 1 refers to motor loads and provides an allowance for motor-starting currents and allows motor loads to be calculated using Article 430.

Exception No. 2 states that service overcurrent protection may follow 240.4(B) or (C), which allows the next higher standard setting of overcurrent devices, ***if*** the service is rated 800 amps or less. When service calculations call for overcurrent protection devices larger than 800-A, you must size down to the next lowest standard.

Exception No. 3 states provision for two to six sets of circuit breakers or fuses to be used to provide overload protection. The sum of the ratings of the circuit breakers or fuses can be larger than the ampacity of the service conductors, providing the service conductors are sized to carry the calculated load.

Exception No. 4 refers to overcurrent protection for fire pumps.

Exception No. 5 allows service overcurrent protection for 120/240-volt, 3-wire, single-phase dwelling services to be selected in accordance with 310.15(B)(7).

Question 73: Which of the following statements about overcurrent protection (under 800 amps) for service conductors is true?

A: Overcurrent protection for service conductors can be installed downstream from the service equipment.
B: Overcurrent protection for service conductors is provided by the utility company and is not covered by the NEC.
C: Overcurrent protection for service conductors is required to be installed in both ungrounded and in grounded service conductors.
D: Overcurrent protection for service conductors can be set at the next higher standard setting of overcurrent devices, if the service conductors are rated between standard size overcurrent device ratings.

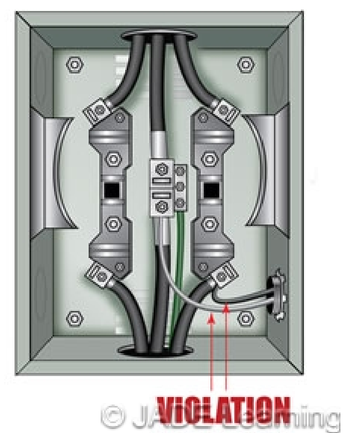
## Question 74: 230.94 Relative Location of the Service Overcurrent Device and Other Service Equipment.

Question ID#: 11376.1

The service overcurrent device(s) must protect all circuits and devices. With six exceptions, nothing else can be connected ahead of the service overcurrent devices.

The following devices may be connected on the supply side of the service overcurrent devices: (1) The service switch, (2) Instrument transformers and Type 1 surge-protective devices, (3) Load management devices, (4) Fire alarm, fire pump or other protective signaling systems, (5) Meters in metal housings, properly grounded and not over 600 volts, (6) The control circuit for shunt-trip breakers or other power operated service equipment.

A common Code violation is to connect equipment ahead of the service overcurrent devices. Unlicensed, unqualified people sometimes try to add a circuit ahead of the main breaker if there is no room left in the existing service panel. This violates a number of rules, including: (1) Breaking the seal on a utility meter, (2) Possibly overloading the service conductors, (3) Possibly running unprotected service wires inside a building with no disconnecting means, (4) Violating the 1 wire per terminal rule, (5) Improper grounding, and a number of other important Code requirements.



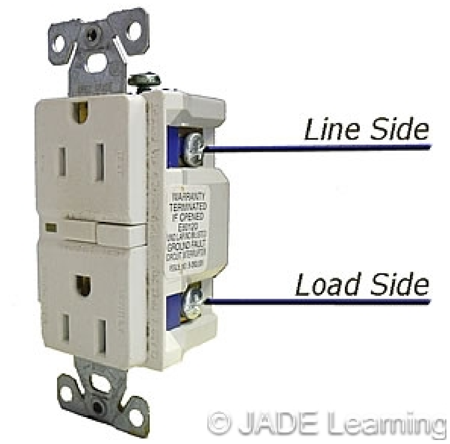

***With 6 exceptions, equipment cannot be connected on the line side of the service disconnecting means.***

Question 74: Which of the following is not permitted to be connected ahead of the overcurrent devices protecting the service conductors?

A: Circuit for a fire pump.
B: An instrument transformer.
C: A feeder supplying a distribution panel in another building.
D: The control circuit for a shunt trip breaker.

## Question 75: 210.8 Ground-Fault Circuit-Interrupter Protection for Personnel.

Question ID#: 11377.0




***Ground-fault circuit-interrupter receptacles must be wired correctly or they will not work.***

GFCI receptacles will not work if they are wired backward. Older style GFCI receptacles will still provide power to the plugged-in load if the line and load connections are reversed, they just won't provide GFCI protection. The most recent generation of GFCI receptacles will not work at all, so it will be obvious that something is wrong.

The GFCI's that are commonly used to protect personnel are called Class A GFCI. The definition of Ground Fault Circuit Interrupters in Article 100 includes a FPN (Fine Print Note) explaining that Class A GFCIs are designed to trip when there is a current imbalance of 6 mA or higher between the circuit conductors getting their power from the GFCI device (this includes an appliance that is plugged in to the face of the device OR a load that is connected to the "load" side screws of the device - or all loads being powered by a GFCI circuit-breaker). The information in the FPN is from UL 943, Standard for Ground-Fault Circuit Interrupters.

The electronics in the newest generation of GFCI device is less vulnerable to being damaged by voltage surges and more immune to electrical noise. Their printed circuit boards also have a coating that makes them more resistant to moisture and corrosion.

GFCI receptacles now have a light that is normally off. If the light is on it indicates a problem and the receptacle will not work. The light will come on if the test button is pressed or if there is a ground-fault on the system. The light will come on if the line and load connections have been reversed or if the GFCI receptacle has been damaged.

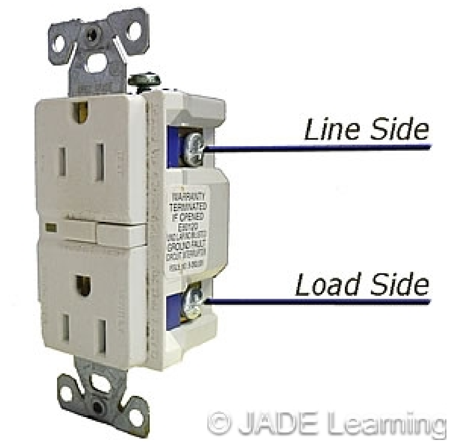
GFCI protection, especially in dwellings, has made a tremendous difference in the number of people receiving shock from defective wiring and in some cases faulty appliances. The number of electrocutions in the home has dropped dramatically since GFCI protection was introduced in the early '70s. The extra money for GFCI receptacles should be well worth it to the customer since it adds a higher level of protection for the homeowner and his/her family.

Question 75: A 20 amp Class A GFCI receptacle outlet:

A: Will de-energize a circuit when it detects a current to ground imbalance for a plugged in hair dryer measuring 6 mA or higher.
B: Will trip on a 21 amp overload.
C: Provides 20 amps of overcurrent protection for equipment.
D: Is required to protect all 120 volt, 20 amp branch circuits that supply outlets in bedrooms and bathrooms.

## Question 76: 210.8 Ground-Fault Circuit-Interrupter Protection for Personnel.

Question ID#: 11377.1




***Ground-fault circuit-interrupter receptacles must be wired correctly or they will not work.***

GFCI receptacles will not work if they are wired backward. Older style GFCI receptacles will still provide power to the plugged-in load if the line and load connections are reversed, they just won't provide GFCI protection. The most recent generation of GFCI receptacles will not work at all, so it will be obvious that something is wrong.

The GFCI's that are commonly used to protect personnel are called Class A GFCI. The definition of Ground Fault Circuit Interrupters in Article 100 includes a FPN (Fine Print Note) explaining that Class A GFCIs are designed to trip when there is a current imbalance of 6 mA or higher between the circuit conductors getting their power from the GFCI device (this includes an appliance that is plugged in to the face of the device OR a load that is connected to the "load" side screws of the device - or all loads being powered by a GFCI circuit-breaker). The information in the FPN is from UL 943, Standard for Ground-Fault Circuit Interrupters.

The electronics in the newest generation of GFCI device is less vulnerable to being damaged by voltage surges and more immune to electrical noise. Their printed circuit boards also have a coating that makes them more resistant to moisture and corrosion.

GFCI receptacles now have a light that is normally off. If the light is on it indicates a problem and the receptacle will not work. The light will come on if the test button is pressed or if there is a ground-fault on the system. The light will come on if the line and load connections have been reversed or if the GFCI receptacle has been damaged.

GFCI protection, especially in dwellings, has made a tremendous difference in the number of people receiving shock from defective wiring and in some cases faulty appliances. The number of electrocutions in the home has dropped dramatically since GFCI protection was introduced in the early '70s. The extra money for GFCI receptacles should be well worth it to the customer since it adds a higher level of protection for the homeowner and his/her family.

Question 76: Class A ground fault protective devices are required to protect 125-V, 15 & 20-amp receptacles in all the following locations except:

A: Dwelling unit bedrooms.
B: Where they serve a bathroom counter top adjacent to a sink.
C: Where they serve a kitchen counter tops.
D: On a temporary service on a construction site.

## Question 77: 210.12 Arc-Fault Circuit-Interrupter Protection.

Question ID#: 11378.1

Most 15- and 20-amp, 120-volt branch circuits supplying outlets or devices in dwelling units must be provided with arc-fault circuit interrupter protection (AFCI). This includes receptacle outlets, lighting outlets, other outlets, and devices such as switches.

***Combination type arc-fault circuit-interrupter protection is required in those locations in a dwelling that require arc-fault protection.***

Combination AFCIs are designed to detect parallel arcing faults between grounded and ungrounded conductors as well as series arcing faults that occur between the ends of a break in either a grounded or an ungrounded conductor in a cable, cord or branch-circuit.

In dwelling units all 120-volt, 15- and 20-amp branch-circuits that supply devices or outlets in the following locations are required to be protected by a combination type AFCI device: kitchens, family rooms, dining rooms, living rooms, parlors, libraries, dens, bedrooms, sunrooms, recreation rooms, closets, hallways, laundry areas, or similar rooms or areas. Areas within dwelling units that do not have to be provided with AFCI protection include bathrooms, garages, attics, crawlspaces, and outdoor outlets.

The 2017 NEC made changes to the AFCI requirements for dormitory units. The change now includes outlets ***and devices*** installed in dormitory bedrooms, living rooms, hallways, closets, ***bathrooms,*** and similar rooms. The requirement for both outlets and devices has been included to provide protection for receptacle outlets, luminaires, smoke detectors, and other equipment supplied by these branch-circuits. Bathrooms have been added to the list of rooms requiring AFCI protection in dormitory units.

An ***Exception*** exempts an individual branch circuit supplying a fire alarm panel from the AFCI requirements provided the circuit is installed in RMC, IMC, EMT, or steel sheathed cable, Type AC or Type MC, with metal junction boxes.

Question 77: In a new dwelling where is AFCI protection required?

A: Living Rooms.
B: Outdoors.
C: Garages.
D: Bathrooms.

## Question 78: 210.20 Protecting Branch Circuit Continuous Loads.

Question ID#: 11379.0

A continuous load is ***a load where the maximum current is expected to continue for 3 hours or more*** (Article 100). Overcurrent protection for continuous loads must be sized at no less than 125% of the load.

***Continuous loads are protected at no less than 125% of the calculated current.***

The increase in the fuse or breaker size is not because the current from a load increases when a load operates for more than 3 hours. The problem with continuous loads is the heat that is generated in the conductors and the terminals they are connected to.

Heat is produced when current flows. When conductors are sized correctly and the loads do not run continuously the heat produced by current flow is managed by properly sizing the conductors and the devices they are attached to. However, as current flows through a conductor and its termination points the heat builds up over time. The NEC has determined that loads operated for 3 hours or more cause significant heat to build up which adversely affects conductors, terminations, and overcurrent devices. Increasing the rating of overcurrent devices and the ampacity of conductors required for continuous loads by 125% compensates for the heat that builds up at the conductor terminations.

Circuit breakers are thermal-magnetic devices. Increased heat at the breaker terminals can possibly cause a breaker to trip earlier at a current below the designed overcurrent protection. Larger circuit conductors and larger breakers will compensate for any heat buildup caused by continuous loads. The conductor acts like a heat-sink and pulls heat away from the breaker terminals and reduces nuisance tripping caused by thermal buildup within the breaker.

The Code has specific rules for designing branch-circuits that serve continuous loads. The overcurrent protection ***shall not be less than*** 125% of the continuous load, and the conductors serving the overcurrent protection device shall be sized to meet the conditions of 240.4, they are sized to the rating of the overcurrent protection device.

When using 125% to determine the overcurrent protection device, write the value as a decimal. 125% is written as a decimal by moving the decimal point to the left 2 places as follows: 125% = 1.25.

To increase the breaker or conductor size for a continuous load by 125%, multiply the continuous load current by 1.25.

***Example 1***: Determine the right size breaker and conductor for a 40-amp continuous load as follows: 40 amps x 1.25 = 50 amps. Use a 50-A breaker and select a conductor that has an ampacity of at least 50 amps.

To find the maximum continuous load allowed on a breaker, multiply the breaker rating by the reciprocal of 1.25, 1/1.25 = .80, or 80%. A 20-A breaker can serve a 16 amp continuous load, 20-A x .80 = 16 amps.

***Example 2***: Determine the largest continuous load that can be protected by a 60-amp breaker on a conductor that has a 60-amp rating as follows: 60-A x .80 = 48 amps. Check that a load rated at 48 amps is the largest load that can be protected by a 60-A breaker by multiplying 48 amps by 1.25: 48-A x 1.25 = 60-A.

Question 78: What is the minimum standard circuit breaker rating for a 65 amp continuous load? (Standard circuit breaker ratings are listed in 240.6)

A: 90 amps.
B: 70 amps.
C: 80 amps.
D: 65 amps.

## Question 79: 210.21 Overcurrent Protection for Outlet Devices.

Question ID#: 11380.0

The rating of a branch circuit is determined by the rating of the overcurrent device (210.18). If a branch circuit has a 15 amp load, 30 amp wire and a 20 amp circuit breaker, it is considered a 20 amp branch circuit.

The rating of a single receptacle supplied by an individual branch circuit must not be less than the rating of the branch circuit. In other words, if a 30 amp circuit breaker supplies a single receptacle outlet and no other outlets, then the rating of that receptacle must be 30 amps.

Where a branch circuit supplies two or more receptacles, the load on a receptacle cannot exceed that shown in Table 210.21(B)(2). The values in the table are based on 80% of the receptacle rating. For example the maximum cord-and-plug connected load on a 15 amp rated receptacle is 12 amps. The receptacle ratings permitted for various size branch circuits are shown in Table 21-.21(B)(3).

Table 210.24 summarizes the required overcurrent protection size for various receptacle ratings: (1) A 15 amp receptacle is protected at 15 amps, (2) A 15 or 20 amp rated receptacle is protected at 20 amps, (3) A 30 amp receptacle is protected at 30 amps, (4) A 40 or 50 amp receptacle is protected at 40 amps, and (5) a 50 amp receptacle is protected at 50 amps.


***When a branch circuit has a single receptacle, the receptacle rating cannot be smaller than the circuit rating.***

Question 79: Which of the following is a Code VIOLATION for a single outlet branch circuit?

A: A 40 amp receptacle protected at 50 amps.
B: A 30 amp receptacle protected at 30 amps.
C: A 24 amp load on a 30 amp receptacle, protected at 30 amps.
D: A 12 amp load, on a 15 amp receptacle, protected atÂ 15 amps.

## Question 80: 210.21 Overcurrent Protection for Outlet Devices.

Question ID#: 11380.1

The rating of a branch circuit is determined by the rating of the overcurrent device (210.18). If a branch circuit has a 15 amp load, 30 amp wire and a 20 amp circuit breaker, it is considered a 20 amp branch circuit.

The rating of a single receptacle supplied by an individual branch circuit must not be less than the rating of the branch circuit. In other words, if a 30 amp circuit breaker supplies a single receptacle outlet and no other outlets, then the rating of that receptacle must be 30 amps.

Where a branch circuit supplies two or more receptacles, the load on a receptacle cannot exceed that shown in Table 210.21(B)(2). The values in the table are based on 80% of the receptacle rating. For example the maximum cord-and-plug connected load on a 15 amp rated receptacle is 12 amps. The receptacle ratings permitted for various size branch circuits are shown in Table 21-.21(B)(3).

Table 210.24 summarizes the required overcurrent protection size for various receptacle ratings: (1) A 15 amp receptacle is protected at 15 amps, (2) A 15 or 20 amp rated receptacle is protected at 20 amps, (3) A 30 amp receptacle is protected at 30 amps, (4) A 40 or 50 amp receptacle is protected at 40 amps, and (5) a 50 amp receptacle is protected at 50 amps.


***When a branch circuit has a single receptacle, the receptacle rating cannot be smaller than the circuit rating.***

Question 80: What is the rating of a circuit using No. 8 AWG copper conductors that supplies a 50-amp receptacle from a 40-amp circuit breaker?

A: 30 amps.
B: 50 amps.
C: 25 amps.
D: 40 amps.

**Answer Sheet** **Darken the correct answer. Sample: A ● C D**

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| | | | |
|---|---|---|---|
| 1.) A B C D | 21.) A B C D | 41.) A B C D | 61.) A B C D |
| 2.) A B C D | 22.) A B C D | 42.) A B C D | 62.) A B C D |
| 3.) A B C D | 23.) A B C D | 43.) A B C D | 63.) A B C D |
| 4.) A B C D | 24.) A B C D | 44.) A B C D | 64.) A B C D |
| 5.) A B C D | 25.) A B C D | 45.) A B C D | 65.) A B C D |
| 6.) A B C D | 26.) A B C D | 46.) A B C D | 66.) A B C D |
| 7.) A B C D | 27.) A B C D | 47.) A B C D | 67.) A B C D |
| 8.) A B C D | 28.) A B C D | 48.) A B C D | 68.) A B C D |
| 9.) A B C D | 29.) A B C D | 49.) A B C D | 69.) A B C D |
| 10.) A B C D | 30.) A B C D | 50.) A B C D | 70.) A B C D |
| 11.) A B C D | 31.) A B C D | 51.) A B C D | 71.) A B C D |
| 12.) A B C D | 32.) A B C D | 52.) A B C D | 72.) A B C D |
| 13.) A B C D | 33.) A B C D | 53.) A B C D | 73.) A B C D |
| 14.) A B C D | 34.) A B C D | 54.) A B C D | 74.) A B C D |
| 15.) A B C D | 35.) A B C D | 55.) A B C D | 75.) A B C D |
| 16.) A B C D | 36.) A B C D | 56.) A B C D | 76.) A B C D |
| 17.) A B C D | 37.) A B C D | 57.) A B C D | 77.) A B C D |
| 18.) A B C D | 38.) A B C D | 58.) A B C D | 78.) A B C D |
| 19.) A B C D | 39.) A B C D | 59.) A B C D | 79.) A B C D |
| 20.) A B C D | 40.) A B C D | 60.) A B C D | 80.) A B C D |

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